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(54) Title: HEMATOPOIETIN RECEPTORS HPR1 AND HPR2

(57) Abstract: This invention relates to human and murine HPR1 and human and murine HPR2 polypeptides, new members of the hematopoietin receptor polypeptide family; to methods of making such HPR1 and HPR2 polypeptides; to non-human mammals in which the endogenous genomic sequences encoding HPR1 and/or HPR2 polypeptides have been partially or completely inactivated; to methods of using HPR1 or HPR2 polypeptides to identify compounds that alter HPR1 or HPR2 polypeptide activities; and to methods of preparing medicaments for and/or treating conditions associated with hematopoietin receptor function.



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**HEMATOPOIETIN RECEPTORS HPR1 AND HPR2**

This application claims the benefit under 35 U.S.C. 119(e) of U.S. provisional applications Serial No. 60/238,706, filed 06 October 2000; Serial No. 60/240,476, filed 13 October 2000; and Serial No. 60/270,282, filed 20 February 2001; all of which are incorporated by reference herein.

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**FIELD OF THE INVENTION**

This invention relates to new human and murine hematopoietin receptor polypeptides HPR1 and HPR2, and to methods of making and using HPR1 and HPR2 polypeptides.

**BACKGROUND OF THE INVENTION**

The hematopoietin receptor polypeptides are a related group of Type I membrane protein  
15 receptors, and in some cases soluble forms of those receptors; this family of polypeptides has variously been called the cytokine receptor family or the hematopoietin receptor family. There are other families of receptors that bind cytokines or growth factors, such as the IL-1 receptor family, the TNF receptor family, and the EGF receptor family, but the hematopoietin receptor family is considered to be a distinct group or family of receptors based on certain characteristic structural features or motifs that are  
20 shared by members of this family. Some of the members of the hematopoietin receptor family are gp130, the granulocyte colony-stimulating factor receptor (GCSFR), leukemia inhibitory factor receptor (LIF-R), the alpha chains and the common beta chain of the IL-3 and IL-5 receptors, etc.; the hematopoietin receptor family contains more than 20 different polypeptides.

Common structural features of the hematopoietin receptor family of polypeptides include at  
25 least one extracellular cytokine receptor domain, which usually contains four cysteines and a WSXWS motif (where W is tryptophan, S is serine, and X indicates any amino acid), and, in most members of the family, a transmembrane and a cytoplasmic domain. The extracellular cytokine receptor domain is involved in ligand-binding activity, and the intracellular domain of a 'signaling' subfamily of hematopoietin receptors has a signal transduction function, transmitting the signal generated by ligand  
30 binding to a signal transduction pathway that results in the expression of genes involved in cell proliferation, differentiation, and/or activation. These activities of the hematopoietin receptor polypeptide family are mediated through interactions with cytokine ligands and other ligand-binding receptor molecules, with ligand binding to the cytokine receptor domain of hematopoietin receptor polypeptides and facilitating homo- or heterotypic interactions between receptor polypeptides, bringing  
35 the cytoplasmic domains of receptors into proximity with each other. Many of the cytokine ligands (such as IL-2, IL-6, or ciliary neurotrophic factor or CNTF, for example) interact with more than one type of heteromeric hematopoietin receptor complex, often with differing affinities, and "common" hematopoietin receptor polypeptides such as gp130 are involved in several different heteromeric receptor complexes that bind a variety of ligands. Because of their ligand-binding and intracellular  
40 signaling activities, hematopoietin receptor polypeptides are associated with a wide variety of conditions involving cytokine-influenced cell proliferation, differentiation, or activation. For example, interaction of the gp130 hematopoietin receptor polypeptide with its binding partners is involved in the



5 normal upregulation of cardiac myocyte proliferation ("hypertrophy") in response to biomechanical stress on the heart, as lack of gp130 leads to heart failure under those conditions (Hirota *et al.*, 1999, *Cell* 97(2): 189-198). Hematopoietin receptors are also involved in the activation or stimulation of cells in response to environmental factors, for example the activation of hepatocytes in the acute-phase inflammatory response to injury (Taga and Kishimoto, 1992, *Crit Rev Immunol.* 11(5): 265-280; Neben and Turner, 1993, *Stem Cells* 11 Suppl 2: 156-162). Hematopoietin receptor family polypeptides generally are constitutively expressed in many different cell types throughout development, but the expression levels of hematopoietin receptor polypeptides may be up- or downregulated in response to stimuli, and some members of the family exhibit more restricted patterns of expression in particular tissues. Characteristics and activities of the hematopoietin receptor polypeptide family are described further in the following references, which are incorporated by reference herein: Drachman and Kaushansky, 1995, *Curr Opin Hematol.* 2(1): 22-28; Ihle, 1995, *Nature* 377(6550): 591-594; Taga and Kishimoto, 1995, *Curr Opin Immunol.* 7(1): 17-23; Ihle *et al.*, 1995, *Annu Rev Immunol.* 13: 369-398; Theze, 1994, *Eur Cytokine Netw.* 5(4): 353-368; Ihle *et al.*, 1994, *Trends Biochem Sci.* 19(5): 222-227; Cosman, 1993, *Cytokine* 5(2): 95-106; and Onishi *et al.*, 1998, *Int Rev Immunol.* 16(5-6): 617-634.

20 In order to develop more effective treatments for disorders such as neurological, cardiac, hematopoietic, immunological, hepatic, and pulmonary conditions and diseases involving cell proliferation, differentiation, or activation, including neoplastic transformation or proliferation of virus-infected or cancerous cells, information is needed about previously unidentified members of the hematopoietin receptor polypeptide family.

## 25 SUMMARY OF THE INVENTION

The present invention is based upon the discovery of new human hematopoietin receptor family members, HPR1 and HPR2.

The invention provides an isolated polypeptide consisting of, consisting essentially of, or more preferably, comprising an amino acid sequence selected from the group consisting of:

- 30 (a) the amino acid sequence of SEQ ID NO:4;
- (b) amino acids 56 through 77 of SEQ ID NO:1;
- (c) an amino acid sequence selected from the group consisting of: amino acids 1 through 55 of SEQ ID NO:1; amino acids 5 through 40 of SEQ ID NO:2; amino acids 1 through 32 of SEQ ID NO:4; amino acids 1 through 241 of SEQ ID NO:4; amino acids 1 through 525 of SEQ ID NO:4; amino acids 20 through 32 of SEQ ID NO:4; amino acids 33 through 134 of SEQ ID NO:4; amino acids Xaa1 through Xaa2 of SEQ ID NO:4, wherein Xaa1 is selected from the group consisting of amino acids 33 through 43 of SEQ ID NO:4 and Xaa2 is selected from the group consisting of amino acids 228 through 241 of SEQ ID NO:4; amino acids 33 through 238 of SEQ ID NO:4; amino acids 33 through 241 of SEQ ID NO:4; amino acids 33 through 525 of SEQ ID NO:4; amino acids 33 through 745 of SEQ ID NO:4; amino acids 44 through 94 of SEQ ID NO:4; amino acids 139 through 241 of SEQ ID NO:4; amino acids 242 through 326 of SEQ ID NO:4; amino acids 242 through 514 of SEQ ID NO:4; amino acids 337 through 419 of SEQ ID NO:4;

- 5 amino acids 433 through 514 of SEQ ID NO:4; amino acids 526 through 556 of SEQ ID NO:4; amino acids 533 through 552 of SEQ ID NO:4; amino acids 553 through 745 of SEQ ID NO:4; amino acids 557 through 745 of SEQ ID NO:4; amino acids 563 through 573 of SEQ ID NO:4; amino acids 563 through 641 of SEQ ID NO:4; amino acids 567 through 581 of SEQ ID NO:4; amino acids 588 through 639 of SEQ ID NO:4; and amino acids 631 through 641 of SEQ ID NO:4;
- 10 (d) fragments of the amino acid sequences of any of (a)-(c) comprising at least 20 contiguous amino acids;
- (e) fragments of the amino acid sequences of any of (a)-(c) comprising at least 30 contiguous amino acids;
- 15 (f) fragments of the amino acid sequences of any of (a)-(c) having HPR1 polypeptide activity;
- (g) fragments of the amino acid sequences of any of (a)-(c) comprising cytokine receptor domain amino acid sequences;
- (h) an allelic variant of any of (a)-(c);
- 20 (i) amino acid sequences comprising at least 20 amino acids and sharing amino acid identity with the amino acid sequences of any of (a)-(h), wherein the percent amino acid identity is selected from the group consisting of: at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, at least 97.5%, at least 99%, and at least 99.5%;
- (j) an amino acid sequence of any of (a)-(i) wherein the polypeptide comprising said amino acid sequence also comprises an amino acid sequence selected from the group consisting of
- 25 SEQ ID NO:10, SEQ ID NO:11, amino acids 652 through 745 of SEQ ID NO:4, a fragment of the sequence of amino acids 652 through 745 of SEQ ID NO:4 comprising at least 20 contiguous amino acids; a fragment of the sequence of amino acids 652 through 745 of SEQ ID NO:4 comprising at least 30 contiguous amino acids; a fragment of the sequence of amino acids 652
- 30 through 745 of SEQ ID NO:4 that is at least 25% of the length of the sequence of amino acids 652 through 745 of SEQ ID NO:4; a fragment of the sequence of amino acids 652 through 745 of SEQ ID NO:4 that is at least 50% of the length of the sequence of amino acids 652 through 745 of SEQ ID NO:4; and a fragment of the sequence of amino acids 652 through 745 of SEQ ID NO:4 comprising at least one tyrosine residue;
- 35 (k) an amino acid sequence of any of (a)-(j) wherein the polypeptide comprising said amino acid sequence does not comprise an amino acid sequence selected from the group consisting of amino acids 239 through 252 of SEQ ID NO:13; amino acids 643 through 652 of SEQ ID NO:14; and amino acids 652 through 662 of SEQ ID NO:15;
- (l) an amino acid sequence of (i)-(k), wherein a polypeptide comprising said amino acid
- 40 sequence of (i)-(k) binds to an antibody that also binds to a polypeptide comprising an amino acid sequence of any of (a)-(h); and
- (m) an amino acid sequence of (i)-(l) having HPR1 polypeptide activity.

5 Preferably, such polypeptides are isolated HPR1 polypeptides or isolated polypeptides having HPR1 polypeptide activity.

Other aspects of the invention are isolated nucleic acids encoding polypeptides of the invention, with a preferred embodiment being an isolated nucleic acid consisting of, consisting essentially of, or more preferably, comprising a nucleotide sequence selected from the group consisting of:

- 10 (a) SEQ ID NO:3;
- (b) SEQ ID NO:5;
- (c) nucleotides 132 through 2366 of SEQ ID NO:3; and
- (d) allelic variants of (a)-(c).

An additional preferred embodiment of the invention is an isolated nucleic acid consisting of, consisting essentially of, or more preferably, comprising a nucleotide sequence selected from the group consisting of nucleotides 1 through 137 of SEQ ID NO:3, nucleotides 138 through 228 of SEQ ID NO:3, nucleotides 229 through 346 of SEQ ID NO:3, nucleotides 347 through 528 of SEQ ID NO:3, nucleotides 529 through 680 of SEQ ID NO:3, nucleotides 681 through 846 of SEQ ID NO:3, nucleotides 847 through 926 of SEQ ID NO:3, nucleotides 927 through 1143 of SEQ ID NO:3, nucleotides 1144 through 1326 of SEQ ID NO:3, nucleotides 1327 through 1428 of SEQ ID NO:3, nucleotides 1429 through 1575 of SEQ ID NO:3, nucleotides 1576 through 1716 of SEQ ID NO:3, nucleotides 1717 through 1810 of SEQ ID NO:3, nucleotides 1811 through 1892 of SEQ ID NO:3, and nucleotides 1893 through 2480 of SEQ ID NO:3.

The invention provides an isolated polypeptide consisting of, consisting essentially of, or more preferably, comprising an amino acid sequence selected from the group consisting of:

- 25 (a) the amino acid sequence of SEQ ID NO:21;
- (b) an amino acid sequence selected from the group consisting of: amino acids 1 through 177 of SEQ ID NO:16; amino acids 216 through 245 of SEQ ID NO:16; SEQ ID NO:17; SEQ ID NO:18; and amino acids 349 through 356 of SEQ ID NO:23;
- 30 (c) an amino acid sequence selected from the group consisting of: amino acids 1 through 23 of SEQ ID NO:21; amino acids 1 through 124 of SEQ ID NO:21; amino acids 1 through 318 of SEQ ID NO:21; amino acids 1 through 331 of SEQ ID NO:21; amino acids 1 through 355 of SEQ ID NO:21; amino acids Xaa1 through Xaa2 of SEQ ID NO:21, wherein Xaa1 is selected from the group consisting of amino acids 24 through 30 of SEQ ID NO:21 and Xaa2 is selected from the group consisting of amino acids 115 through 124 of SEQ ID NO:21; amino acids 24 through 124 of SEQ ID NO:21; amino acids 24 through 331 of SEQ ID NO:21; amino acids 24 through 355 of SEQ ID NO:21; amino acids Xaa3 through Xaa4 of SEQ ID NO:21, wherein Xaa3 is selected from the group consisting of amino acids 125 through 133 of SEQ ID NO:21 and Xaa4 is selected from the group consisting of amino acids 309 through 331 of SEQ ID NO:21; amino acids 125 through 219 of SEQ ID NO:21; amino acids 125 through 331 of SEQ ID NO:21; amino acids 133 through 309 of SEQ ID NO:21; amino acids 224 through 320 of SEQ ID NO:21; amino acids 224 through 331 of SEQ ID NO:21; amino acids 319 through 565 of SEQ ID NO:21; amino acids Xaa5 through

- 5 Xaa6 of SEQ ID NO:21, wherein Xaa5 is selected from the group consisting of amino acids 376 through 393 of SEQ ID NO:21 and Xaa6 is selected from the group consisting of amino acids 618 through 629 of SEQ ID NO:21; amino acids 376 through 629 of SEQ ID NO:21; amino acids 393 through 440 of SEQ ID NO:21; amino acids 393 through 618 of SEQ ID NO:21; and amino acids 397 through 611 of SEQ ID NO:21;
- 10 (d) fragments of the amino acid sequences of any of (a)-(c) comprising at least 20 contiguous amino acids;
- (e) fragments of the amino acid sequences of any of (a)-(c) comprising at least 30 contiguous amino acids;
- (f) fragments of the amino acid sequences of any of (a)-(c) having HPR2 polypeptide activity;
- 15 (g) fragments of the amino acid sequences of any of (a)-(c) comprising cytokine receptor domain amino acid sequences;
- (h) an allelic variant of any of (a)-(c);
- (i) amino acid sequences comprising at least 20 amino acids and sharing amino acid identity with the amino acid sequences of any of (a)-(h), wherein the percent amino acid identity is selected from the group consisting of: at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, at least 97.5%, at least 99%, and at least 99.5%;
- 20 (j) an amino acid sequence of any of (a)-(i) wherein the polypeptide comprising said amino acid sequence also comprises an amino acid sequence selected from the group consisting of:
- 25 amino acids 1 through 177 of SEQ ID NO:16; amino acids 216 through 245 of SEQ ID NO:16; SEQ ID NO:17; SEQ ID NO:18; amino acids 349 through 356 of SEQ ID NO:23; amino acids 319 through 565 of SEQ ID NO:21; amino acids Xaa5 through Xaa6 of SEQ ID NO:21, wherein Xaa5 is selected from the group consisting of amino acids 376 through 393 of SEQ ID NO:21 and Xaa6 is selected from the group consisting of amino acids 618 through 629 of SEQ ID NO:21; amino acids 376 through 629 of SEQ ID NO:21; amino acids 393 through 440 of SEQ ID NO:21; amino acids 393 through 618 of SEQ ID NO:21; amino acids 397 through 611 of SEQ ID NO:21; amino acids 381 through 629 of SEQ ID NO:21; a fragment of the sequence of amino acids 381 through 629 of SEQ ID NO:21 comprising at least 20 contiguous amino acids; a fragment of the sequence of amino acids 381 through 629 of SEQ ID NO:21 comprising at least 30 contiguous amino acids; a fragment of the sequence of amino acids 381 through 629 of SEQ ID NO:21 that is at least 25% of the length of the sequence of amino acids 381 through 629 of SEQ ID NO:21; a fragment of the sequence of amino acids 381 through 629 of SEQ ID NO:21 that is at least 50% of the length of the sequence of amino acids 381 through 629 of SEQ ID NO:21; a fragment of the sequence of amino acids 381 through 629 of SEQ ID NO:21 comprising at least one of the following: an HPR2 Box 1 motif, an HPR2 Box 2 motif, and an HPR2 Box 3 motif; and a fragment of the sequence of amino acids 381 through 629 of SEQ ID NO:21 comprising at least one tyrosine residue;
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- 40

- 5 (k) an amino acid sequence of any of (a)-(j) wherein the polypeptide comprising said amino acid sequence does not comprise amino acids 381 through 384 of SEQ ID NO:26;
- (l) an amino acid sequence of (i)-(k), wherein a polypeptide comprising said amino acid sequence of (i)-(k) binds to an antibody that also binds to a polypeptide comprising an amino acid sequence of any of (a)-(h); and
- 10 (m) an amino acid sequence of (i)-(l) having HPR2 polypeptide activity.

Preferably, such polypeptides are isolated HPR2 polypeptides or isolated polypeptides having HPR2 polypeptide activity.

Other aspects of the invention are isolated nucleic acids encoding polypeptides of the invention, with a preferred embodiment being an isolated nucleic acid consisting of, consisting essentially of, or

15 more preferably, comprising a nucleotide sequence selected from the group consisting of:

- (a) SEQ ID NO:19;
- (b) SEQ ID NO:20;
- (c) SEQ ID NO:22;
- (d) SEQ ID NO:24; and
- 20 (d) allelic variants of (a)-(d).

An additional preferred embodiment of the invention is an isolated nucleic acid consisting of, consisting essentially of, or more preferably, comprising a nucleotide sequence selected from the group consisting of nucleotides 107 through 175 of SEQ ID NO:19, nucleotides 107 through 478 of SEQ ID NO:19, nucleotides 107 through 1060 of SEQ ID NO:19, nucleotides 107 through 1099 of SEQ ID NO:19, nucleotides 107 through 1171 of SEQ ID NO:19, nucleotides 176 through 478 of SEQ ID NO:19, nucleotides 176 through 1099 of SEQ ID NO:19, nucleotides 176 through 1171 of SEQ ID NO:19, nucleotides 479 through 763 of SEQ ID NO:19, nucleotides 479 through 1099 of SEQ ID NO:19, nucleotides 503 through 1033 of SEQ ID NO:19, nucleotides 776 through 1066 of SEQ ID NO:19, nucleotides 776 through 1099 of SEQ ID NO:19, nucleotides 1061 through 1801 of SEQ ID NO:19, nucleotides 1232 through 1993 of SEQ ID NO:19, nucleotides 1283 through 1426 of SEQ ID NO:19, nucleotides 1283 through 1960 of SEQ ID NO:19, and nucleotides 1295 through 1939 of SEQ ID NO:19.

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The invention also provides isolated genomic nucleic acids corresponding to the nucleic acids of the invention.

35 Another aspect of the invention provides isolated nucleic acids, preferably having a length of at least 15 nucleotides, that hybridize under conditions of moderate stringency to the nucleic acids encoding polypeptides of the invention. In preferred embodiments of the invention, such nucleic acids encode a polypeptide having HPR1 and/or HPR2 polypeptide activity, or comprise a nucleotide sequence that shares nucleotide sequence identity with the nucleotide sequences of the nucleic acids of the invention, wherein the percent nucleotide sequence identity is selected from the group consisting of: at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, at least 97.5%, at least 99%, and at least 99.5%.

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5 Further provided by the invention are expression vectors and recombinant host cells comprising at least one nucleic acid of the invention, and preferred recombinant host cells wherein said nucleic acid is integrated into the host cell genome.

Also provided is a process for producing a polypeptide encoded by the nucleic acids of the invention, comprising culturing a recombinant host cell under conditions promoting expression of said polypeptide, wherein the recombinant host cell comprises at least one nucleic acid of the invention. A preferred process provided by the invention further comprises purifying said polypeptide. In another aspect of the invention, the polypeptide produced by said process is provided.

Further aspects of the invention are isolated antibodies that bind to the polypeptides of the invention, preferably monoclonal antibodies, also preferably humanized antibodies or humanized antibodies, and preferably wherein the antibody inhibits the activity of said polypeptides.

The invention additionally provides a method of designing an inhibitor of the polypeptides of the invention, the method comprising the steps of determining the three-dimensional structure of any such polypeptide, analyzing the three-dimensional structure for the likely binding sites of substrates, synthesizing a molecule that incorporates a predicted reactive site, and determining the polypeptide-inhibiting activity of the molecule.

In a further aspect of the invention, a method is provided for identifying compounds that alter HPR1 and/or HPR2 polypeptide activity comprising

- (a) mixing a test compound with a polypeptide of the invention; and
- (b) determining whether the test compound alters the HPR1 and/or HPR2 polypeptide activity of said polypeptide.

In another aspect of the invention, a method is provided identifying compounds that inhibit the binding activity of HPR1 and/or HPR2 polypeptides comprising

- (a) mixing a test compound with a polypeptide of the invention and a binding partner of said polypeptide; and
- (b) determining whether the test compound inhibits the binding activity of said polypeptide.

In preferred embodiments, the binding partner is a four alpha helix bundle cytokine; more preferably, the binding partner is selected from the group consisting of IL-6, OSM, LIF, CNTF, CLC, IL-12p35, and IL-23p19, and most preferably the binding partners are a soluble hematopoietin receptor such as EBI-3, soluble IL-6R alpha, cytokine-like factor-1 (CLF), IL-12p40, or a soluble form of HPR1 and/or HPR2 in conjunction with a four alpha helix bundle cytokine.

The invention also provides a method for increasing ligand-binding activity, comprising providing at least one compound selected from the group consisting of the polypeptides of the invention and agonists of said polypeptides; with a preferred embodiment of the method further comprising increasing said activity in a patient by administering at least one polypeptide of the invention.

- 5 Further provided by the invention is a method for decreasing ligand-binding activity, comprising providing at least one antagonist of the polypeptides of the invention; with a preferred embodiment of the method further comprising decreasing said activity in a patient by administering at least one antagonist of the polypeptides of the invention, and with a further preferred embodiment wherein the antagonist is an antibody that inhibits the activity of any of said polypeptides.
- 10 The invention additionally provides a method for treating a cell proliferation condition comprising administering at least one compound selected from the group consisting of the polypeptides of the invention and agonists of said polypeptides; with a preferred embodiment wherein the cell proliferation condition is selected from the group consisting of pancytopenia, leukopenia, anemia, thrombocytopenia, neurodegenerative disorders, and osteoporosis resulting from a lack of bone-
- 15 forming cells.
- The invention additionally provides a method for treating a metabolic condition comprising administering at least one compound selected from the group consisting of the polypeptides of the invention and agonists of said polypeptides; with a preferred embodiment wherein the metabolic condition is obesity.
- 20 The invention additionally provides a method for treating a reproductive hormone condition comprising administering at least one compound selected from the group consisting of the polypeptides of the invention and agonists of said polypeptides; with a preferred embodiment wherein the condition is selected from the group consisting of deficient mammary development and infertility.
- In other aspects of the invention, a method is provided for treating a cell proliferation
- 25 condition comprising administering an antagonist of the polypeptide of the invention; with a preferred embodiment wherein the cell proliferation condition is selected from the group consisting of leukemia, tumour metastasis, and osteoporosis resulting from an excess of bone-resorbing cells.
- In other aspects of the invention, a method is provided for treating a metabolic condition comprising administering an antagonist of the polypeptide of the invention; with a preferred
- 30 embodiment wherein the metabolic condition is selected from the group consisting of cachexia, wasting, and AIDS-related weight loss.
- In other aspects of the invention, a method is provided for treating cancer conditions stimulated by reproductive hormones comprising administering an antagonist of the polypeptide of the invention; with a preferred embodiment wherein the condition is selected from the group consisting of
- 35 breast cancer and prolactinoma.
- In another embodiment of the invention, methods are provided for using HPR1 and HPR2 polypeptides and antagonists thereof as adjuvants.
- A further embodiment of the invention provides a use for the polypeptides of the invention in the preparation of a medicament for treating a cell proliferation condition; with a preferred embodiment
- 40 wherein the cell proliferation condition is selected from the group consisting of pancytopenia, leukopenia, anemia, thrombocytopenia, neurodegenerative disorders, and osteoporosis.

5 A further embodiment of the invention provides a use for the polypeptides of the invention in the preparation of a medicament for treating a metabolic condition; with a preferred embodiment wherein the metabolic condition is obesity.

A further embodiment of the invention provides a use for the polypeptides of the invention in the preparation of a medicament for treating a reproductive hormone condition; with a preferred  
10 embodiment wherein the condition is selected from the group consisting of deficient mammary development and infertility.

### **DETAILED DESCRIPTION OF THE INVENTION**

#### **Similarities of HPR1 and HPR2 Structure to Other Hematopoietin Receptor Family Members**

We have identified HPR1 and HPR2, new human hematopoietin receptor polypeptides having  
15 structural features characteristic of this polypeptide family; the amino acid sequence of an HPR1 polypeptide is provided in SEQ ID NO:4 and the amino acid sequence of three alternatively spliced forms of HPR2 polypeptide are provided in SEQ ID NOs 21, 23, and 25. We have also identified the murine homologue of human HPR1; the amino acid sequence of *Mus musculus* HPR1 is presented in SEQ ID NO:12. (The use of "HPR1" without a species designation refers to HPR1 polypeptides  
20 generally, for example, human and/or murine, mammalian, or vertebrate HPR1 polypeptides.) Alignments showing the sequence similarities between HPR1, HPR2, and other hematopoietin receptors are presented in Tables 1, 2, and 3 in Example 1 below.

The typical structural elements common to members of the hematopoietin receptor polypeptide family include an extracellular region comprising at least one cytokine receptor domain,  
25 and in most members of the family, a cytoplasmic region that in at least a subset of the hematopoietin receptor polypeptides comprises domains involved in intracellular signaling functions. A signal sequence is found at the N-terminus of hematopoietin receptor family polypeptides, and is followed, in N-to-C order, by an immunoglobulin (Ig)-like domain (in some members of the family), a cytokine receptor domain, three copies of a fibronectin repeat (in some members of the family), a  
30 transmembrane domain or a glycosyl-phosphatidyl inositol (GPI) linkage to the membrane (except in soluble members of the family, which in most cases are soluble splice variant forms of transmembrane or membrane-linked hematopoietin receptor polypeptides), and a cytoplasmic domain (which is not present in soluble forms). The extracellular domain of hematopoietin receptor polypeptides extends from the N terminus to the transmembrane domain of the protein, and includes the cytokine receptor  
35 domain and any Ig-like domains (approximately 100 amino acids in length) or fibronectin repeats (such as fibronectin type III repeats which are approximately 81-83 amino acids in length and are separated by spacer sequences of approximately 10 to 13 amino acids) that may be present in certain of the hematopoietin receptor polypeptides. There are key residues within the cytokine receptor domain, the two or four conserved cysteine residues and the WSXWS motif; substitutions of these residues are  
40 likely to be associated with an altered function or lack of that function for the polypeptide. The cytokine receptor domain, which is approximately 200 amino acids in length, can be subdivided into two roughly equal subdomains - an N-terminal 'conserved cysteine' domain and a more C-terminal



- 5 'WSXWS' domain - separated by a proline-rich 'linker' stretch of four amino acids that allows the two subdomains to form a ligand binding site between them (Bravo and Heath, 2000, *EMBO J.* 19(11): 2399-2411).

The intracellular domain (also called "cytoplasmic domain") of the hematopoietin receptor polypeptides (in those family members that contain such a domain), extends from the transmembrane domain of the protein to the C terminus, and in the signaling receptor subgroup, includes regions involved in intracellular signal transduction functions. Although the amino acid sequence of the intracellular domain varies considerably between hematopoietin receptor polypeptides, there are a few regions that show some similarity between the members of the family and which have been determined to be involved in binding to members of the signal transduction cascade. "Box 1" is a stretch of 9 to 12 amino acids that begins about 9 amino acids C-terminal to the transmembrane domain, and has within it a conserved Ar-P-X-Al-P-X-P motif, where Ar is an aromatic amino acid (Trp, Phe, or Tyr) and Al is an aliphatic amino acid (Ala, Gly, Val, Leu, or Ile). About 8 amino acids C-terminal to Box 1 there is a conserved aromatic amino acid (usually Trp but also Phe or Tyr), and approximately 15 to 60 amino acids further C-terminal there is a motif of about 11 to 13 amino acids, "Box 2". While Box 1 is present in most of the hematopoietin receptor polypeptides, the Box 2 motif is present in a subset of the hematopoietin receptor family including gp130, GCSFR, LIF-R, the erythropoietin receptor (EPO-R), and several others. Mutations to residues within Box 1 or Box 2, or to the conserved aromatic residue between the Box 1 and Box 2 motifs, have inactivated the ability of the mutated receptor to stimulate cell proliferation upon the addition of ligand. A further conserved domain has been identified in the cytoplasmic domains of signaling cytokine receptors such as gp130, LIF-R, and G-CSFR: "Box 3". The Box 3 motif is about 10 to 15 amino acids located between approximately 70 and 150 amino acids C-terminal of the transmembrane domain, and has a rough match to a (P/T)VXGXGYXXQ consensus sequence. Cytoplasmic regions of these receptors containing Box 3 have been associated with a macrophage differentiation promoting activity (in the case of gp130) and a granulocyte differentiation promoting activity (in the case of G-CSFR) (Soede-Bobok and Touw, 1997, *J Mol Med* 75: 470-477); however, members of the LIF/IL-6 gp130-sharing family of hematopoietin receptors can also be involved in suppression of differentiation (see Ernst *et al.*, 1999, *J Biol Chem* 274(14): 9729-9737). Finally, the cytoplasmic domains of signaling hematopoietin receptor polypeptides contain several tyrosine residues that are potential sites for phosphorylation. Although hematopoietin receptors themselves do not generally have a protein kinase activity, they interact with and are phosphorylated by kinases within the JAK/STAT signal transduction pathways. Mutations in the Box 1 motif abolish the ability of certain of the signaling hematopoietin receptors to bind members of the Janus kinase (JAK) family, particularly JAK2 or JAK1 (Taner *et al.*, 1995, *J Biol Chem* 270(12): 6523-6530). Hematopoietin receptor-ligand interactions also activate the ERK/MAPK pathway, most likely through the phosphorylation of tyrosine residues in the cytoplasmic domains as the tyrosines at cytoplasmic positions 118 of gp130 (amino acid 759 of SEQ ID NO:8) and 115 of LIF-R (amino acid 974 of SEQ ID NO:6) are present within SHP2 binding sites (Schiemann *et al.*, 1997, *J Biol Chem* 272(26): 16631-

5 16636). The cytoplasmic tyrosine residues of signaling hematopoietin receptors and the amino acids around them are also important motifs for the recruitment and phosphorylation of signal-transducing STAT polypeptides (Hirano *et al.*, 2000, *Oncogene* 19: 2548-2556).

Human HPR1 polypeptide has a signal sequence extending from approximately amino acid 20 through amino acid 32 of SEQ ID NO:4, with the mature polypeptide produced by cleavage of this  
 10 signal sequence predicted to have an amino acid sequence beginning at amino acid 33 of SEQ ID NO:4. Human HPR1 has a cytokine receptor domain extending approximately from amino acid 33 through amino acid 241 of SEQ ID NO:4; three fibronectin repeats from approximately amino acid 242 of SEQ ID NO:4 to about amino acid 515 of SEQ ID NO:4; a transmembrane domain that begins approximately between amino acids 526 and 533 of SEQ ID NO:4 and extends to approximately  
 15 between amino acids 552 and 556 of SEQ ID NO:4 (defining a smaller 'core' transmembrane domain from amino acid 533 to amino acid 552 of SEQ ID NO:4 and an extended transmembrane domain from amino acid 526 to amino acid 556 of SEQ ID NO:4); and a cytoplasmic domain extending from the end of the transmembrane domain (i.e. beginning roughly between amino acids 553 and 557 of SEQ ID NO:4) and extending through the carboxyl terminus of the polypeptide (amino acid 745 of SEQ ID  
 20 NO:4). Therefore, human HPR1 polypeptide has an overall structure consistent with other hematopoietin receptor family members. The four conserved cysteine residues within the human HPR1 cytokine receptor domain are located at positions 43, 53, 81, and 94 of SEQ ID NO:4, and the human HPR1 WSXWS motif is located from amino acid 224 through amino acid 228 of SEQ ID NO:4. The human HPR1 N-terminal cytokine receptor subdomain containing four conserved cysteine residues  
 25 extends approximately from amino acid 33 of SEQ ID NO:4 to amino acid 134 of SEQ ID NO:4; the proline-rich linker is amino acids 135 through 138 of SEQ ID NO:4; and the WSXWS-containing C-terminal cytokine receptor subdomain extends from amino acid 139 to about amino acid 241 of SEQ ID NO:4. In human HPR1, as in several members of the hematopoietin receptor family, the cytokine receptor domain is followed by three fibronectin type III repeats; these repeats are located within the  
 30 human HPR1 amino acid sequence of SEQ ID NO:4 at the following approximate locations: amino acids 242 to 244 through 324 to 326, amino acids 336 to 337 through 419 to 422, and amino acids 430 to 433 through 514 to 515. Within its intracellular domain, human HPR1 polypeptide contains a good match to the Box 1 conserved motif from amino acid 563 through amino acid 573 of SEQ ID NO:4, a conserved downstream Trp residue (amino acid 581 of SEQ ID NO:4), and a Box 2 motif from amino  
 35 acid 631 to amino acid 641 of SEQ ID NO:4. The cytoplasmic domains of signaling hematopoietin receptor polypeptides contain several tyrosine residues that are potential sites for phosphorylation; in human HPR1, such tyrosines are located at positions 652, 683, and 721 of SEQ ID NO:4. Human HPR1 contains several instances of an Asp-containing motif within its cytoplasmic region. In the area overlapping the Box 2 location, human HPR1 has repeated amino acid sequences as shown in the  
 40 following table; these sequences form a consensus sequence of DKL(N/V)(T/Al), where Al is an aliphatic residue as described above. Other signaling hematopoietin receptors such as murine HPR1 (at

- 5 amino acids 600 through 604 of SEQ ID NO:12) and gp130 also contain at least one similar Asp-containing sequence in the region around and following the Box 2 location.

Repeat Sequence	Location in SEQ ID NO:4
DKLNL	amino acids 588 through 592
DSVNT	amino acids 597 through 601
DRILK	amino acids 603 through 607
DKLVI	amino acids 614 through 618
DKLVV	amino acids 619 through 623
DEART	amino acids 635 through 639

- 10 Variants, presumably splice variants, of human HPR1 are described in WO 00/75314: a 252-amino-acid form ("NR10.2"), a 652-amino-acid form ("NR10.1"), and a 662-amino-acid form ("NR10.3").
- 15 The 252-amino-acid form of HPR1 (SEQ ID NO:13) is identical to SEQ ID NO:4 through amino acid 238, and then has a divergent amino acid sequence from amino acid 239 through 252 of SEQ ID NO:13. This 252-amino-acid form of human HPR1 therefore does not contain the fibronectin type III repeats found in the full-length 745-amino-acid HPR1 of SEQ ID NO:4, or the transmembrane domain or the intracellular region of the SEQ ID NO:4 polypeptide. The 652-amino-acid form of HPR1 (SEQ
- 20 ID NO:14) is identical to SEQ ID NO:4 through amino acid 642, and then has a divergent amino acid sequence from amino acid 643 through 652 of SEQ ID NO:14.; and the 662-amino-acid form of HPR1 (SEQ ID NO:15) is identical to SEQ ID NO:4 through amino acid 651, and then has a divergent amino acid sequence from amino acid 652 through 662 of SEQ ID NO:15. The 652- and 662-amino-acid forms of human HPR1 therefore do not contain the tyrosine residues at positions 652, 683, and 721 of the intracellular region of the SEQ ID NO:4 polypeptide which are potential substrates for phosphorylation by kinases, such as those of the ERK/MAPK signaling pathways.

- 25 The Mus musculus HPR1 amino acid sequence of SEQ ID NO:12 has a signal sequence beginning approximately between amino acid 13 and amino acid 16 of SEQ ID NO:12 and extending approximately through amino acid 28 of SEQ ID NO:12, with the mature polypeptide produced by cleavage of this signal sequence predicted to have an amino acid sequence beginning at amino acid 29 of SEQ ID NO:12. Murine HPR1 has a cytokine receptor domain extending approximately from amino acid 29 through amino acid 224 of SEQ ID NO:12; three fibronectin repeats from approximately amino acid 225 of SEQ ID NO:12 to about amino acid 499 of SEQ ID NO:12; a transmembrane domain that begins approximately between amino acids 510 and 517 of SEQ ID NO:12 and extends to approximately between amino acids 532 and 533 of SEQ ID NO:12 (defining a smaller 'core'
- 30 transmembrane domain from amino acid 517 to amino acid 532 of SEQ ID NO:12 and an extended transmembrane domain from amino acid 510 to amino acid 533 of SEQ ID NO:12); and a cytoplasmic domain extending from the end of the transmembrane domain (i.e. beginning roughly between amino acids 533 and 534 of SEQ ID NO:12) and extending through the carboxyl terminus of the polypeptide
- 35 (amino acid 726 of SEQ ID NO:12). Therefore, murine HPR1 polypeptide has an overall structure consistent with other hematopoietin receptor family members. There are two conserved cysteine residues within the murine HPR1 cytokine receptor domain located at positions 39 and 49 of SEQ ID NO:12, and there are two additional cysteines in this region (although at non-conserved positions) at

5 amino acids 90 and 97 of SEQ ID NO:12. The murine HPR1 WSXWS motif is located from amino acid 207 through amino acid 211 of SEQ ID NO:12. The murine HPR1 N-terminal cytokine receptor subdomain containing two conserved cysteine residues (and two additional cysteine residues) extends approximately from amino acid 29 of SEQ ID NO:12 to amino acid 124 of SEQ ID NO:12; the proline-rich linker is amino acids 125 through 128 of SEQ ID NO:12; and the WSXWS-containing C-terminal  
 10 cytokine receptor subdomain extends from amino acid 129 to about amino acid 224 of SEQ ID NO:12. In murine HPR1, as in several members of the hematopoietin receptor family, the cytokine receptor domain is followed by three fibronectin type III repeats; these repeats are located within the murine HPR1 amino acid sequence of SEQ ID NO:12 at the following approximate locations: amino acids 225 to 227 through 307 to 309 , amino acids 319 to 320 through 403 to 406, and amino acids 413 to  
 15 417 through 498 to 499. Within its intracellular domain, murine HPR1 polypeptide contains a good match to the Box 1 conserved motif from amino acid 547 through amino acid 557 of SEQ ID NO:12, a conserved downstream Trp residue (amino acid 565 of SEQ ID NO:12), and a Box 2 motif from amino acid 612 through amino acid 622 of SEQ ID NO:12. The cytoplasmic domains of signaling hematopoietin receptor polypeptides contain several tyrosine residues that are potential sites for  
 20 phosphorylation; in murine HPR1, such tyrosines are located at positions 633, 674, and 701 of SEQ ID NO:12.

Human HPR2 polypeptide has a signal sequence extending from approximately amino acid 11 through amino acid 23 of SEQ ID NO:21, with the mature polypeptide produced by cleavage of this signal sequence predicted to have an amino acid sequence beginning at amino acid 24 of SEQ ID  
 25 NO:21. The membrane-spanning (629 amino acids) form of HPR2 has an N-terminal Ig-like domain extending approximately from amino acid 24 through amino acid 124 of SEQ ID NO:21, a cytokine receptor domain extending approximately from amino acid 125 through an amino acid from 320 to 331 of SEQ ID NO:21; a transmembrane domain that begins approximately at amino acid 356 of SEQ ID NO:21 and extends to approximately amino acid 375 of SEQ ID NO:21; and a cytoplasmic domain  
 30 extending from the end of the transmembrane domain (i.e. beginning approximately at amino acid 376 of SEQ ID NO:21) and extending through the carboxyl terminus of the polypeptide (amino acid 629 of SEQ ID NO:21). Therefore, HPR2 polypeptide has an overall structure consistent with other hematopoietin receptor family members. The N-terminal Ig-like domain contains six cysteine residues at positions 30, 52, 59, 101, 105, and 115 of SEQ ID NO:21, the most conserved of which appear to be  
 35 the two cysteines at positions 52 and 101; the cysteines at positions 30, 115 (and to a lesser extent, at 105) also align with cysteines at similar positions in Ig or Ig-like domains. The HPR2 Ig-like domain appears to have the greatest degree of sequence similarity with members of the LIR (leukocyte Ig-like receptor) polypeptide family, particularly LIR-3 and LIR-4. The two conserved cysteine residues within the human HPR2 cytokine receptor domain are located at amino acid positions 133 and 144 of  
 40 SEQ ID NO:21, and the HPR2 version of the WSXWS motif, which has a glutamine residue at the second position of the motif rather than a serine residue, is located from amino acid 304 through amino acid 308 of SEQ ID NO:21. The HPR2 N-terminal cytokine receptor subdomain containing the two

5 conserved cysteine residues extends approximately from amino acid 125 of SEQ ID NO:21 to amino acid 219 of SEQ ID NO:21; the proline-rich linker (in this case, proline- and alanine-rich) is amino acids 220 through 223 of SEQ ID NO:21; and the 'WQXWS'-containing C-terminal cytokine receptor subdomain extends from amino acid 224 through an amino acid from 320 to 331 of SEQ ID NO:21. HPR2 does not contain the fibronectin type III repeats found in human and murine HPR1. Within its  
 10 intracellular domain, the membrane-spanning (629 amino acids) form of HPR2 contains a good match to the Box 1 conserved motif from amino acid 393 through amino acid 403 of SEQ ID NO:21, does not contain a Trp residue between Box 1 and Box2, and has a Box 2 motif from amino acid 430 to amino acid 440 of SEQ ID NO:21. There are also two matches to the Box 3 motif in this membrane-spanning HPR2 polypeptide, at amino acids 478 through 491 and at amino acids 605 through 618 of SEQ ID  
 15 NO:21. The cytoplasmic domains of signaling hematopoietin receptor polypeptides contain several tyrosine residues that are potential sites for phosphorylation; in human HPR2, such tyrosines are located at amino acid positions 397 (within the Box 1 motif), 429 (immediately N-terminal to the Box 2 motif), 450, 463, and 476 (just N-terminal of the most N-terminal Box 3 motif), and amino acids 484 and 611 (each of these last two amino acids is within a Box 3 motif) of SEQ ID NO:21. In several  
 20 respects, the membrane-spanning form of HPR2 shows similarity to the LIF-R hematopoietin receptor: both of these molecules have an Ig-like domain that is followed by a cytokine receptor domain having two (as compared to four) conserved cysteines; and both have Box 1, Box 2, and Box 3 motifs in their intracellular domains, and do not have a tryptophan residue between Box 1 and Box 2.

The HPR2-ex9 polypeptide of SEQ ID NO:23 (356 amino acids), created by alternative  
 25 splicing which removes exon 9 of the HPR2 coding sequence (see Example 1 below), is identical to the HPR2 629-amino-acid form from amino acid 1 through amino acid 348, but then diverges in sequence for the eight amino acids from amino acid 349 to the C terminus at amino acid 356. The HPR2-ex9 form does not contain a transmembrane region, and is expected to be a secreted form of HPR2 containing the HPR2 extracellular Ig-like and cytokine receptor domains. The HPR2-ex8-ex9  
 30 polypeptide of SEQ ID NO:25 (565 amino acids), created by alternative splicing which removes exons 8 and 9 of the HPR2 coding sequence (see Example 1 below), is identical to the HPR2 629-amino-acid form from amino acid 1 through amino acid 318, is missing the next 64 amino acids which include the transmembrane domain, but then shows identity between amino acid 319 through amino acid 565 of SEQ ID NO:25 and the C-terminal region of the 629-amino-acid form of HPR2. The HPR2-ex8-ex9  
 35 form is also expected to be a secreted form of HPR2 containing not only the HPR2 extracellular Ig-like and cytokine receptor domains, but also the C-terminal portion of the HPR2 protein which includes the Box 1, Box 2, and Box 3 motifs. A variant, presumably a splice variant, of human HPR2 is described in WO 00/73451: a 384-amino-acid form ("DCRS2"). This 384-amino-acid form of HPR2 (SEQ ID NO:26) is identical to SEQ ID NO:21 through amino acid 380, and then has a divergent amino acid  
 40 sequence from amino acid 381 through 384 of SEQ ID NO:26. This 384-amino-acid form of human HPR2 therefore does not contain the intracellular region of the SEQ ID NO:21 HPR2 polypeptide,

5 which contains the Box1, 2, and 3 motifs and intracellular tyrosine residues that are involved in the signaling (or signal transduction) function of the SEQ ID NO:21 HPR2 polypeptide.

The *Mus musculus* HPR2 amino acid sequence of SEQ ID NO:27 has a signal sequence beginning approximately between amino acid 8 and amino acid 11 and extending through amino acid 23 of SEQ ID NO:27, with the mature polypeptide produced by cleavage of this signal sequence predicted to have an amino acid sequence beginning at amino acid 24 of SEQ ID NO:27. *Mus musculus* HPR2, like the membrane-spanning form of human HPR2, has an N-terminal Ig-like domain extending approximately from amino acid 24 through amino acid 124 of SEQ ID NO:27, a cytokine receptor domain extending approximately from amino acid 125 through an amino acid from 341 to 350 of SEQ ID NO:27; a transmembrane domain that begins approximately between amino acid 373 and amino acid 380 of SEQ ID NO:27 and extends through approximately between amino acid 394 and amino acid 395 of SEQ ID NO:27 (defining a smaller 'core' transmembrane domain from amino acid 380 to amino acid 394 of SEQ ID NO:27 and an extended transmembrane domain from amino acid 373 to amino acid 395 of SEQ ID NO:27); and a cytoplasmic domain extending from the end of the transmembrane domain (i.e. beginning approximately at amino acid 395 or at amino acid 396 of SEQ ID NO:27) and extending through the carboxyl terminus of the polypeptide (amino acid 644 of SEQ ID NO:27). Therefore, murine HPR2 polypeptide has an overall structure consistent with other hematopoietin receptor family members. The N-terminal Ig-like domain contains six cysteine residues at positions 30, 52, 59, 101, 105, and 115 of SEQ ID NO:27, the most conserved of which appear to be the two cysteines at positions 52 and 101; the cysteines at positions 30, 115 (and to a lesser extent, at 105) also align with cysteines at similar positions in Ig or Ig-like domains. As with human HPR2, the murine HPR2 Ig-like domain appears to have the greatest degree of sequence similarity with members of the LIR (leukocyte Ig-like receptor) polypeptide family. The two conserved cysteine residues within the human HPR2 cytokine receptor domain are located at amino acid positions 133 and 144 of SEQ ID NO:27, and the murine HPR2 version of the "WSXWS" motif, which like human HPR2 has a glutamine residue at the second position of the motif rather than a serine residue, is located from amino acid 324 through amino acid 328 of SEQ ID NO:27. The murine HPR2 polypeptide contains an insert of 20 amino acids relative to the human HPR2 polypeptide; this insert region extends from amino acid 297 through amino acid 316 of SEQ ID NO:27, and is a perfect repeat of amino acids 317 through 336 of SEQ ID NO:27. Therefore, in the SEQ ID NO:27 form of murine HPR2, there is a second WQXWS motif at amino acids 304 through 308 of SEQ ID NO:27. The murine HPR2 N-terminal cytokine receptor subdomain containing the two conserved cysteine residues extends approximately from amino acid 125 of SEQ ID NO:27 to amino acid 219 of SEQ ID NO:27; the proline-rich linker (in this case, proline- and alanine-rich) is amino acids 220 through 223 of SEQ ID NO:27; and the C-terminal cytokine receptor subdomain containing the two repeats of the WQXWS motif extends from amino acid 224 through an amino acid from 340 to 350 of SEQ ID NO:27. Murine HPR2 does not contain the fibronectin type III repeats found in human and murine HPR1. Within its intracellular domain, this membrane-spanning form of murine HPR2 contains a good match to the Box 1 conserved motif from

5 amino acid 412 through amino acid 422 of SEQ ID NO:27, does not contain a Trp residue between Box 1 and Box2, and has a Box 2 motif from amino acid 449 to amino acid 459 of SEQ ID NO:27. There are also two matches to the Box 3 motif in this murine membrane-spanning HPR2 polypeptide, at amino acids 498 through 511 and at amino acids 620 through 633 of SEQ ID NO:27. The cytoplasmic domains of signaling hematopoietin receptor polypeptides contain several tyrosine residues that are potential sites for phosphorylation; in murine HPR2, such tyrosines are located at amino acid positions 416 (within the Box 1 motif), 448 (immediately N-terminal to the Box 2 motif), 469, and 496 (just N-terminal of the most N-terminal Box 3 motif), and amino acids 504 and 626 (each of these last two amino acids is within a Box 3 motif) of SEQ ID NO:27. There is an additional intracellular tyrosine located at position 542 of SEQ ID NO:27. As with the membrane-spanning form of human HPR2, murine HPR2 shows similarity to the LIF-R hematopoietin receptor.

Each of the HPR1 and the HPR2 groups of related polypeptides therefore contains a distinct subset of the several features characteristic of at least some members of the hematopoietin receptor family. The skilled artisan will recognize that the boundaries of the regions of the HPR1 and HPR2 polypeptides described above are approximate and that the precise boundaries of such domains, as for example the boundaries of the transmembrane region (which can be predicted by using computer programs available for that purpose), can also differ from member to member within the hematopoietin receptor polypeptide family.

The hematopoietin receptor polypeptide family is highly to moderately conserved between species, with the family members within a particular species exhibiting some sequence conservation, particularly with respect to the conserved domains and residues described above. Subfamilies of the hematopoietin receptor polypeptide family can be defined on the basis of structure, for example the Ig-like domain containing members, or the fibronectin repeat containing members. It is also possible to group hematopoietin receptor polypeptides according to the length of the cytoplasmic domain, with those receptors having a longer cytoplasmic domain being more likely to be signaling receptors. Subgroups of the hematopoietin receptor family can also be defined on the basis of a shared common signaling receptor present in several different combinations of heteromeric receptors. For example, the gp130 signaling receptor is found in separate complexes with LIF-R, IL-6R alpha or a soluble form of IL-6R alpha, and CNTFR alpha; monomeric forms or multimeric combinations of these receptor components bind to IL-6, OSM, LIF, and/or CNTF; thus a "gp130-sharing group" subfamily would include these hematopoietin receptor polypeptides and be associated with this group of cytokines. Another group of hematopoietin receptors are those which associate with a ligand comprising at least two soluble polypeptides. For example, the IL-12 receptor associates with the combination of the p40 polypeptide, similar in structure to soluble forms of hematopoietin receptors such as soluble IL-6R alpha, and the four alpha helix bundle p35 polypeptide. The IL-12 p40 subunit can also associate with another four alpha helix bundle cytokine called p19; when p40 binds p19 the resulting combination has been named "IL-23" and has been shown to bind to the IL-12R beta 1 receptor subunit, but not the signaling IL-12R beta 2 receptor subunit (Oppmann *et al.*, 2000, *Immunity* 13: 715-725). Thus the

5 p40-p19 complex is likely to bind a different IL-12RB2-like signaling receptor subunit, such as HPR2, HPR1, GCSFR, or gp130. As another example, CNTFR alpha, gp130, and LIFR can each associate with a combination of the soluble receptor cytokine-like factor-1 (CLF-1) and cardiotrophin-like cytokine (CLC), with CLF-1 and CLC analogous to p40 and p35, respectively (Elson *et al.*, 2000, *Nat Neurosci* 3(9): 867-872). The cytokine receptor domains of HPR1 and HPR2 are similar in sequence  
 10 to those of gp130, IL-6R beta, IL-12RB2, GCSFR, LIFR, leptin receptor, prolactin receptor, and other members of the hematopoietin receptor family, with HPR1 showing the greatest degree of similarity to gp130 and IL-6R beta, and HPR2 showing the greatest degree of similarity to gp130 and IL-12RB2. Because HPR1 and HPR2 each have a substantial cytoplasmic domain and are most similar in sequence to gp130, HPR1 and HPR2 are likely to be new signaling members of the "gp130-sharing" subfamily  
 15 of hematopoietin receptors; however, HPR2 may also share attributes of the IL-12RB2 receptor subunit, such as involvement in modulation of the balance between Th1 and Th2 immune responses. Expression of HPR1 and HPR2 has been detected by PCR amplification from tissue-specific cDNA libraries in several cell types including COS-1 cells, 293MSR cells, the B cell lines CB23 and MP-1, the B cell lymphoma lines Daudi, and Raji, the T cell leukemia line HSB2, and the promonocytic leukemia line U937. HPR2 mRNA expression appears to be more prevalent than HPR1 expression in the B cell derived lines, while HPR1 mRNA expression appears to be more prevalent than HPR2 expression in the T cell derived and monocyte lines. EBI-3 is a p40-like soluble hematopoietin receptor polypeptide; FACS analysis has shown that EBI-3-Fc fusion polypeptides bind to cells expressing HPR1 and HPR2 such as COS-1 cells, 293MSR cells, and CB23 and MP-1 cells, indicating  
 20 that EBI-3 is a potential binding partner of HPR1 and HPR2, most likely in conjunction with a four alpha helix bundle cytokine such as IL-6, OSM, LIF, CNTF, CLC, IL-12p35, or IL-23p19.

#### **Biological Activities and Functions of HPR1 and HPR2 Polypeptides**

PCR amplification from tissue-specific cDNA libraries was performed to detect HPR1 or  
 30 HPR2 cDNA sequences. The results of these experiments show that HPR1 transcripts are expressed in a wide variety of fetal and adult human cells, including testis, lung, placenta, pancreas, prostate, peripheral blood cells, thymus, stomach, and skin cells; as well as in various cell lines including U937 cells, the leukemia cell line HSB2, LX-1/GI-117 lung carcinoma cells, GI-112 colon adenocarcinoma cells, the B cell lines MP-1 and CB23, COS-1 cells, and 293MSR cells. HPR2 transcripts are present  
 35 in a similarly diverse group of adult and fetal human cell types, including placenta, lung, kidney, pancreas, prostate, testis, colon, LX-1/GI-117 lung carcinoma cells, tonsil/CX-1 cells, lymph node, GI-112 colon adenocarcinoma cells, heart, brain, spleen, thymus, ovary, small intestine, fetal brain, fetal lung/heart, fetal spleen, fetal thymus, esophagus, stomach, and skin; and in various cell lines such as the B cell lines MP-1 and CB23, Daudi cells, Raji cells, HSB2 cells, COS-1 cells, and 293MSR cells.

40 Typical biological activities or functions associated with HPR1 and HPR2 polypeptides are ligand-binding activity, intracellular signaling activity, cell proliferation stimulatory activity, cell proliferation inhibitory activity, cell differentiation stimulatory activity, and cell differentiation



5 inhibitory activity. HPR1 and HPR2 polypeptides having ligand-binding activity bind to cytokine or growth factor ligand molecules of the four alpha helix bundle family of cytokines, and in particular are likely to bind cytokines such as IL-6, OSM, LIF, CNTF, CLC, IL-12p35, and IL-23p19, and/or soluble hematopoietin receptors such as EBI-3, soluble IL-6R alpha, cytokine-like factor-1 (CLF), IL-12p40, or a soluble form of HPR1 and/or HPR2. This ligand-binding activity is associated with the extracellular  
10 cytokine receptor domain of HPR1 polypeptides. Thus, for uses requiring ligand-binding activity, preferred HPR1 and HPR2 polypeptides include those having at least one cytokine receptor domain and exhibiting ligand-binding activity. Preferred HPR1 and HPR2 polypeptides further include oligomers or fusion polypeptides comprising at least one cytokine receptor portion of one or more HPR1 and/or HPR2 polypeptides, and fragments of any of these polypeptides that have ligand-binding activity. The  
15 ligand-binding activity of HPR1 and HPR2 polypeptides may be determined, for example, by any standard assay to measure binding of labeled ligand or by a competitive binding assay, all of which are described more extensively below. HPR1 and HPR2 polypeptides having intracellular signaling activity bind ligand molecules when in association with other receptor polypeptides to form a homo- or heteromeric complex, with ligand binding initiating a signaling cascade. The intracellular signaling  
20 activity is associated with the cytoplasmic domain of certain HPR1 and HPR2 polypeptides. Thus, for uses requiring intracellular signaling activity, preferred HPR1 and HPR2 polypeptides include those having the cytoplasmic domain, and in particular having certain conserved domains (such as the Box 1 motif, the Trp residue at position 581 of SEQ ID NO:4, the Box 2 motif, the Asp-containing motifs between amino acids 588 and 639 of SEQ ID NO:4, or the Box 3 motif) and conserved cytoplasmic  
25 tyrosine residues, and exhibiting intracellular signaling biological activity. Preferred HPR1 and HPR2 polypeptides further include oligomers or fusion polypeptides comprising at least one cytoplasmic portion of one or more HPR1 and/or HPR2 polypeptides, and fragments of any of these polypeptides that have intracellular signaling activity. The intracellular signaling activity of HPR1 and HPR2 polypeptides may be determined, for example, through assays to detect phosphorylation of the HPR1  
30 polypeptide, the HPR2 polypeptide, or downstream polypeptides in signaling cascades such as the JAK/STAT or ERK/MAPK pathways, or in assays that measure biological activities related to the signal transmission, such as stimulation or suppression of cell proliferation, differentiation, or activation. One example of an assay to measure cytokine-binding and cell-proliferation activity involves expressing a polypeptide of the invention in Ba/F3 cells, exposing the polypeptide-expressing  
35 cells to radioactively labeled cytokine, and measuring specific cytokine binding to cells and uptake of <sup>3</sup>H-thymidine by cells in response to cytokine, as described in Presky *et al.*, 1996, *Proc Natl Acad Sci USA* 93: 14002-14007. Further examples of such assays are described herein and in Ernst *et al.*, 1999, *J Biol Chem* 274(14): 9729-9737. Soluble forms of hematopoietin receptors comprising one or more extracellular domains of the hematopoietin receptor, such as soluble forms of HPR1 and HPR2, may  
40 also be used in assays to measure their effect on cell growth, proliferation, differentiation, or activation; in such assays the cells are contacted with the soluble form of the receptor and their growth,

5 proliferation, differentiation, or activation is measured, for example by measuring the incorporation of radioactive thymidine or by microscopic examination of treated and untreated cells.

The terms "HPR1 polypeptide activity" and "HPR2 polypeptide activity," as used herein, include any one or more of the following: ligand-binding activity and intracellular signaling activity (which includes effects on cell growth, proliferation, differentiation, or activation), as well as the *ex vivo* and *in vivo* activities of HPR1 and HPR2 polypeptides. The degree to which HPR1 and HPR2 polypeptides and fragments and other derivatives of these polypeptides exhibit these activities can be determined by standard assay methods as disclosed herein; those of skill in the art will appreciate that other, similar types of assays can be used to measure HPR1 and HPR2 biological activities.

Another aspect of the biological activity of HPR1 and HPR2 polypeptides is the ability of members of these polypeptide families to bind particular binding partners such as cytokines, other hematopoietin receptor polypeptides, and intracellular signaling polypeptides, with the cytokine receptor domain binding to cytokines and the intracellular signaling domain binding to intracellular signaling polypeptides such as members of the JAK and SHP polypeptide families. The term "binding partner," as used herein, includes ligands, receptors, substrates, antibodies, other hematopoietin receptor polypeptides, the same HPR1 or HPR2 polypeptide (in the case of homotypic interactions), and any other molecule that interacts with an HPR1 or an HPR2 polypeptide through contact or proximity between particular portions of the binding partner and the HPR1 or HPR2 polypeptide. Because the cytokine receptor domains of HPR1 and HPR2 polypeptides bind to cytokines, an HPR1 or HPR2 cytokine receptor domain when expressed as a separate fragment from the rest of an HPR1 or HPR2 polypeptide, or as a soluble polypeptide, fused for example to an immunoglobulin Fc domain, is expected to disrupt the binding of endogenous HPR1 and/or HPR2 polypeptides to their binding partners. By binding to one or more binding partners, the separate cytokine receptor domain polypeptide likely prevents binding by the native HPR1 and/or HPR2 polypeptide(s), and so acts in a dominant negative fashion to inhibit the biological activities mediated via binding of HPR1 and/or HPR2 polypeptides to cytokines. Assays for evaluating the biological activities and partner-binding properties of HPR1 and HPR2 polypeptides are described further herein.

HPR1 and HPR2 polypeptides are involved in cell proliferation, differentiation, or activation diseases or conditions, that share as a common feature ligand-binding activity in their etiology. More specifically, the following cell proliferation conditions are those that are known or are likely to involve the biological activities of HPR1 and/or HPR2 polypeptides: pancytopenia, leukopenia, anemia, thrombocytopenia, neurodegenerative disorders, osteoporosis resulting from a lack of bone-forming cells, leukemia, tumour metastasis, and osteoporosis resulting from an excess of bone-resorbing cells. In addition, the following metabolic conditions involving hematopoietin receptor ligands such as leptin are those that are known or are likely to involve the biological activities of HPR1 and/or HPR2 polypeptides: obesity, cachexia, wasting, and AIDS-related weight loss. Also, the following prolactin-related conditions are those that are known or are likely to involve the biological activities of HPR1 and/or HPR2 polypeptides: deficient mammary development, infertility, breast cancer, and

5 prolactinoma. Blocking or inhibiting the interactions between members of the HPR1 and HPR2 polypeptide families and their substrates, ligands, receptors, binding partners, and or other interacting polypeptides is an aspect of the invention and provides methods for treating or ameliorating these diseases and conditions through the use of inhibitors of HPR1 and/or HPR2 polypeptide activity. Examples of such inhibitors or antagonists are described in more detail below. For certain conditions  
10 involving too little HPR1 or HPR2 polypeptide activity, methods of treating or ameliorating these conditions comprise increasing the amount or activity of HPR1 or HPR2 polypeptides by providing isolated HPR1 or HPR2 polypeptides or active fragments or fusion polypeptides thereof, or by providing compounds (agonists) that activate endogenous or exogenous HPR1 or HPR2 polypeptides.

#### **HPR1 and HPR2 Polypeptides**

15 An HPR1 polypeptide is a polypeptide that shares a sufficient degree of amino acid identity or similarity to the human HPR1 polypeptide of SEQ ID NO:4 or the murine HPR1 polypeptide of SEQ ID NO:12 to (A) be identified by those of skill in the art as a polypeptide likely to share particular structural domains and/or (B) have biological activities in common with the HPR1 polypeptides of SEQ ID NO:4 and SEQ ID NO:12 and/or (C) bind to antibodies that also specifically bind to other  
20 HPR1 polypeptides. An HPR2 polypeptide is a polypeptide that shares a sufficient degree of amino acid identity or similarity to the HPR2 polypeptides of SEQ ID NOs 21, 23, 25, and 27 to (A) be identified by those of skill in the art as a polypeptide likely to share particular structural domains and/or (B) have biological activities in common with the HPR2 polypeptides of SEQ ID NOs 21, 23, 25, and 27 and/or (C) bind to antibodies that also specifically bind to other HPR2 polypeptides. HPR1 and  
25 HPR2 polypeptides can be isolated from naturally occurring sources, or have the same structure as naturally occurring HPR1 or HPR2 polypeptides, or can be produced to have structures that differ from naturally occurring HPR1 or HPR2 polypeptides. Polypeptides derived from any HPR1 or HPR2 polypeptide by any type of alteration (for example, but not limited to, insertions, deletions, or substitutions of amino acids; changes in the state of glycosylation of the polypeptide; refolding or  
30 isomerization to change its three-dimensional structure or self-association state; and changes to its association with other polypeptides or molecules) are also HPR1 or HPR2 polypeptides, respectively. Therefore, the polypeptides provided by the invention include polypeptides characterized by amino acid sequences similar to those of the HPR1 and HPR2 polypeptides described herein, but into which modifications are naturally provided or deliberately engineered. A polypeptide that shares biological  
35 activities in common with members of the HPR1 and/or HPR2 polypeptide family is a polypeptide having HPR1 and/or HPR2 polypeptide activity. Examples of biological activities exhibited by HPR1 and/or HPR2 polypeptides include, without limitation, ligand-binding activity and intracellular signaling.

40 The present invention provides both full-length and mature forms of HPR1 and HPR2 polypeptides. Full-length polypeptides are those having the complete primary amino acid sequence of the polypeptide as initially translated. The amino acid sequences of full-length polypeptides can be obtained, for example, by translation of the complete open reading frame ("ORF") of a cDNA

5 molecule. Several full-length polypeptides can be encoded by a single genetic locus if multiple mRNA forms are produced from that locus by alternative splicing or by the use of multiple translation initiation sites. The "mature form" of a polypeptide refers to a polypeptide that has undergone post-translational processing steps such as cleavage of the signal sequence or proteolytic cleavage to remove a prodomain. Multiple mature forms of a particular full-length polypeptide may be produced, for  
10 example by cleavage of the signal sequence at multiple sites, or by differential regulation of proteases that cleave the polypeptide. The mature form(s) of such polypeptide can be obtained by expression, in a suitable mammalian cell or other host cell, of a nucleic acid molecule that encodes the full-length polypeptide. The sequence of the mature form of the polypeptide may also be determinable from the amino acid sequence of the full-length form, through identification of signal sequences or protease  
15 cleavage sites. The HPR1 and HPR2 polypeptides of the invention also include those that result from post-transcriptional or post-translational processing events such as alternate mRNA processing which can yield alternative splice forms of HPR1 or HPR2 such as a truncated but biologically active polypeptide or, for example, a naturally occurring soluble form of the polypeptide. Also encompassed within the invention are variations attributable to proteolysis such as differences in the N- or C-termini  
20 upon expression in different types of host cells, due to proteolytic removal of one or more terminal amino acids from the polypeptide (generally from 1-5 terminal amino acids).

The invention further includes HPR1 and HPR2 polypeptides with or without associated native-pattern glycosylation. Polypeptides expressed in yeast or mammalian expression systems (e.g., COS-1 or CHO cells) can be similar to or significantly different from a native polypeptide in molecular  
25 weight and glycosylation pattern, depending upon the choice of expression system. Expression of polypeptides of the invention in bacterial expression systems, such as *E. coli*, provides non-glycosylated molecules. Further, a given preparation can include multiple differentially glycosylated species of the polypeptide. Glycosyl groups can be removed through conventional methods, in particular those utilizing glycopeptidase. In general, glycosylated polypeptides of the invention can be  
30 incubated with a molar excess of glycopeptidase (Boehringer Mannheim).

Species homologues of HPR1 and HPR2 polypeptides and of nucleic acids encoding them are also provided by the present invention. As used herein, a "species homologue" is a polypeptide or nucleic acid with a different species of origin from that of a given polypeptide or nucleic acid, but with significant sequence similarity to the given polypeptide or nucleic acid, as determined by those of skill  
35 in the art. Species homologues can be isolated and identified by making suitable probes or primers from polynucleotides encoding the amino acid sequences provided herein and screening a suitable nucleic acid source from the desired species. The invention also encompasses allelic variants of HPR1 and HPR2 polypeptides and nucleic acids encoding them; that is, naturally-occurring alternative forms of such polypeptides and nucleic acids in which differences in amino acid or nucleotide sequence are  
40 attributable to genetic polymorphism (allelic variation among individuals within a population).

Fragments of the HPR1 and HPR2 polypeptides of the present invention are encompassed by the present invention and can be in linear form or cyclized using known methods, for example, as

5 described in Saragovi, et al., *Bio/Technology* 10, 773-778 (1992) and in McDowell, et al., *J. Amer. Chem. Soc.* 114 9245-9253 (1992). Polypeptides and polypeptide fragments of the present invention, and nucleic acids encoding them, include polypeptides and nucleic acids with amino acid or nucleotide sequence lengths that are at least 25% (more preferably at least 50%, or at least 60%, or at least 70%, and most preferably at least 80%) of the length of an HPR1 polypeptide or of an HPR2 polypeptide, and have at least 60% sequence identity (more preferably at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, at least 97.5%, or at least 99%, and most preferably at least 99.5%) with that HPR1 or HPR2 polypeptide or encoding nucleic acid, where sequence identity is determined by comparing the amino acid sequences of the polypeptides when aligned so as to maximize overlap and identity while minimizing sequence gaps. Also included in the present invention are polypeptides and polypeptide fragments, and nucleic acids encoding them, that contain or encode a segment preferably comprising at least 8, or at least 10, or preferably at least 15, or more preferably at least 20, or still more preferably at least 30, or most preferably at least 40 contiguous amino acids. Such polypeptides and polypeptide fragments may also contain a segment that shares at least 70% sequence identity (more preferably at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, at least 97.5%, or at least 99%, and most preferably at least 99.5%) with any such segment of any of the HPR1 or HPR2 polypeptides, where sequence identity is determined by comparing the amino acid sequences of the polypeptides when aligned so as to maximize overlap and identity while minimizing sequence gaps. The percent identity can be determined by visual inspection and mathematical calculation. Preferably, the comparison is done using a computer program. An exemplary, preferred computer program is the Genetics Computer Group (GCG; Madison, WI) Wisconsin package version 10.0 program, 'GAP.' The preferred default parameters for the 'GAP' program includes: (1) The GCG implementation of comparison matrices for nucleotides and amino acids; such as a unary comparison matrix (containing a value of 1 for identities and 0 for non-identities) for nucleotides, and the weighted comparison matrix of Gribskov and Burgess, *Nucl. Acids Res.* 14:6745, 1986, as described by Schwartz and Dayhoff, eds., *Atlas of Polypeptide Sequence and Structure*, National Biomedical Research Foundation, pp. 353-358, 1979; (2) a penalty of 30 for each gap and an additional penalty of 1 for each symbol in each gap for amino acid sequences, or penalty of 50 for each gap and an additional penalty of 3 for each symbol in each gap for nucleotide sequences; (3) no penalty for end gaps; and (4) no maximum penalty for long gaps. Another program useful for determining percent identify is the BESTFIT program, also available from the University of Wisconsin as part of the GCG computer package. Default parameters for using the BESTFIT program are the same as those described above for using the GAP program. Other programs used by those skilled in the art of sequence comparison can also be used, such as, for example, the UW-BLAST 2.0 algorithm or the BLASTN program version 2.0.9, available for use *via* the National Library of Medicine website: [ncbi.nlm.nih.gov/gorf/wblast2.cgi](http://ncbi.nlm.nih.gov/gorf/wblast2.cgi). Standard default parameter settings for UW-BLAST 2.0 are described at the following Internet site: [blast.wustl.edu/blast/README.html#References](http://blast.wustl.edu/blast/README.html#References). In addition, the BLAST algorithm uses the BLOSUM62 amino acid scoring matrix, and optional parameters that can

5 be used are as follows: (A) inclusion of a filter to mask segments of the query sequence that have low compositional complexity (as determined by the SEG program of Wootton and Federhen (Computers and Chemistry, 1993); also see Wootton and Federhen, 1996, Analysis of compositionally biased regions in sequence databases, *Methods Enzymol.* 266: 554-71) or segments consisting of short-periodicity internal repeats (as determined by the XNU program of Claverie and States (Computers and Chemistry, 1993)), and (B) a statistical significance threshold for reporting matches against database sequences, or E-score (the expected probability of matches being found merely by chance, according to the stochastic model of Karlin and Altschul (1990); if the statistical significance ascribed to a match is greater than this E-score threshold, the match will not be reported.); preferred E-score threshold values are 0.5, or in order of increasing preference, 0.25, 0.1, 0.01, 0.001, 0.0001, 1e-10, 1e-20, 1e-30, 1e-40, 15 1e-50, 1e-75, or 1e-100.

"An isolated polypeptide consisting essentially of an amino acid sequence" means that the polypeptide may have, in addition to said amino acid sequence, additional material covalently linked to either or both ends of the polypeptide, said additional material preferably between 1 and 10,000 additional amino acids covalently linked to either end, each end, or both ends of polypeptide, and more preferably between 1 and 1,000 additional amino acids covalently linked to either end, each end, or both ends of the polypeptide, and most preferably between 1 and 100 additional amino acids covalently linked to either end, each end, or both ends of the polypeptide. In preferred embodiments, covalent linkage of additional amino acids to either end, each end, or both ends of the polypeptide results in a novel combined amino acid sequence that is neither naturally occurring nor disclosed in the art.

25 The present invention also provides for soluble forms of HPR1 and HPR2 polypeptides comprising or consisting essentially of certain fragments or domains of these polypeptides, and particularly those comprising the extracellular domain or one or more fragments of the extracellular domain. Soluble polypeptides are polypeptides that are capable of being secreted from the cells in which they are expressed. In such forms part or all of the intracellular and transmembrane domains of the polypeptide are deleted such that the polypeptide is fully secreted from the cell in which it is expressed. The intracellular and transmembrane domains of polypeptides of the invention can be identified in accordance with known techniques for determination of such domains from sequence information. Soluble HPR1 and HPR2 polypeptides also include those polypeptides which include part of the transmembrane region, provided that the soluble HPR1 or HPR2 polypeptide is capable of being 30 secreted from a cell, and preferably retains HPR1 and/or HPR2 polypeptide activity. Soluble HPR1 and HPR2 polypeptides further include oligomers or fusion polypeptides comprising the extracellular portion of at least one HPR1 or HPR2 polypeptide, and fragments of any of these polypeptides that have HPR1 and/or HPR2 polypeptide activity. A secreted soluble polypeptide can be identified (and distinguished from its non-soluble membrane-bound counterparts) by separating intact cells which 35 express the desired polypeptide from the culture medium, e.g., by centrifugation, and assaying the medium (supernatant) for the presence of the desired polypeptide. The presence of the desired polypeptide in the medium indicates that the polypeptide was secreted from the cells and thus is a 40

5 soluble form of the polypeptide. The use of soluble forms of HPR1 or HPR2 polypeptides is advantageous for many applications. Purification of the polypeptides from recombinant host cells is facilitated, since the soluble polypeptides are secreted from the cells. Moreover, soluble polypeptides are generally more suitable than membrane-bound forms for parenteral administration and for many enzymatic procedures.

10 In another aspect of the invention, preferred polypeptides comprise various combinations of HPR1 and/or HPR2 polypeptide domains, such as the cytokine receptor domain and the intracellular signaling domain. Accordingly, polypeptides of the present invention and nucleic acids encoding them include those comprising or encoding two or more copies of a domain such as the cytokine receptor domain, two or more copies of a domain such as the intracellular signaling domain, or at least one copy  
15 of each domain, and these domains can be presented in any order within such polypeptides.

Further modifications in the peptide or DNA sequences can be made by those skilled in the art using known techniques. Modifications of interest in the polypeptide sequences can include the alteration, substitution, replacement, insertion or deletion of a selected amino acid. For example, one or more of the cysteine residues can be deleted or replaced with another amino acid to alter the  
20 conformation of the molecule, an alteration which may involve preventing formation of incorrect intramolecular disulfide bridges upon folding or renaturation. Techniques for such alteration, substitution, replacement, insertion or deletion are well known to those skilled in the art (see, e.g., U.S. Pat. No. 4,518,584). As another example, N-glycosylation sites in the polypeptide extracellular domain can be modified to preclude glycosylation, allowing expression of a reduced carbohydrate analog in  
25 mammalian and yeast expression systems. N-glycosylation sites in eukaryotic polypeptides are characterized by an amino acid triplet Asn-X-Y, wherein X is any amino acid except Pro and Y is Ser or Thr. Appropriate substitutions, additions, or deletions to the nucleotide sequence encoding these triplets will result in prevention of attachment of carbohydrate residues at the Asn side chain. Alteration of a single nucleotide, chosen so that Asn is replaced by a different amino acid, for example,  
30 is sufficient to inactivate an N-glycosylation site. Alternatively, the Ser or Thr can be replaced with another amino acid, such as Ala. Known procedures for inactivating N-glycosylation sites in polypeptides include those described in U.S. Patent 5,071,972 and EP 276,846. Additional variants within the scope of the invention include polypeptides that can be modified to create derivatives thereof by forming covalent or aggregative conjugates with other chemical moieties, such as glycosyl groups,  
35 lipids, phosphate, acetyl groups and the like. Covalent derivatives can be prepared by linking the chemical moieties to functional groups on amino acid side chains or at the N-terminus or C-terminus of a polypeptide. Conjugates comprising diagnostic (detectable) or therapeutic agents attached thereto are contemplated herein. Preferably, such alteration, substitution, replacement, insertion or deletion retains the desired activity of the polypeptide or a substantial equivalent thereof. One example is a variant that  
40 binds with essentially the same binding affinity as does the native form. Binding affinity can be measured by conventional procedures, e.g., as described in U.S. Patent No. 5,512,457 and as set forth herein.

5 Other derivatives include covalent or aggregative conjugates of the polypeptides with other polypeptides or polypeptides, such as by synthesis in recombinant culture as N-terminal or C-terminal fusions. Examples of fusion polypeptides are discussed below in connection with oligomers. Further, fusion polypeptides can comprise peptides added to facilitate purification and identification. Such peptides include, for example, poly-His or the antigenic identification peptides described in U.S. Patent  
10 No. 5,011,912 and in Hopp et al., *Bio/Technology* 6:1204, 1988. One such peptide is the FLAG<sup>®</sup> peptide, which is highly antigenic and provides an epitope reversibly bound by a specific monoclonal antibody, enabling rapid assay and facile purification of expressed recombinant polypeptide. A murine hybridoma designated 4E11 produces a monoclonal antibody that binds the FLAG<sup>®</sup> peptide in the presence of certain divalent metal cations, as described in U.S. Patent 5,011,912. The 4E11 hybridoma  
15 cell line has been deposited with the American Type Culture Collection under accession no. HB 9259. Monoclonal antibodies that bind the FLAG<sup>®</sup> peptide are available from Eastman Kodak Co., Scientific Imaging Systems Division, New Haven, Connecticut.

Encompassed by the invention are oligomers or fusion polypeptides that contain an HPR1 polypeptide and/or an HPR2 polypeptide, one or more fragments of HPR1 and/or HPR2 polypeptides,  
20 or any of the derivative or variant forms of HPR1 and HPR2 polypeptides as disclosed herein. In particular embodiments, the oligomers comprise soluble HPR1 and/or HPR2 polypeptides. Oligomers can be in the form of covalently linked or non-covalently-linked multimers, including dimers, trimers, or higher oligomers. In one aspect of the invention, the oligomers maintain the binding ability of the polypeptide components and provide therefor, bivalent, trivalent, etc., binding sites. In an alternative  
25 embodiment the invention is directed to oligomers comprising multiple HPR1 and/or HPR2 polypeptides joined via covalent or non-covalent interactions between peptide moieties fused to the polypeptides, such peptides having the property of promoting oligomerization. Leucine zippers and certain polypeptides derived from antibodies are among the peptides that can promote oligomerization of the polypeptides attached thereto, as described in more detail below.

30 In embodiments where variants of the HPR1 and/or HPR2 polypeptides are constructed to include a membrane-spanning domain, they will form a Type I membrane polypeptide. Membrane-spanning HPR1 and/or HPR2 polypeptides can be fused with extracellular domains of receptor polypeptides for which the ligand is known. Such fusion polypeptides can then be manipulated to control the intracellular signaling pathways triggered by the membrane-spanning HPR1 or HPR2  
35 polypeptide. HPR1 and HPR2 polypeptides that span the cell membrane can also be fused with agonists or antagonists of cell-surface receptors, or cellular adhesion molecules to further modulate HPR1 and/or HPR2 intracellular effects. In another aspect of the present invention, interleukins can be situated between the preferred HPR1 or HPR2 polypeptide fragment and other fusion polypeptide domains.

40 Immunoglobulin-based Oligomers. The polypeptides of the invention or fragments thereof can be fused to molecules such as immunoglobulins for many purposes, including increasing the valency of polypeptide binding sites. For example, fragments of an HPR1 polypeptide and/or of an



5 HPR2 polypeptide can be fused directly or through linker sequences to the Fc portion of an immunoglobulin. For a bivalent form of the polypeptide, such a fusion could be to the Fc portion of an IgG molecule. Other immunoglobulin isotypes can also be used to generate such fusions. For example, a polypeptide-IgM fusion would generate a decavalent form of the polypeptide of the invention. The term "Fc polypeptide" as used herein includes native and mutein forms of polypeptides made up of the Fc region of an antibody comprising any or all of the CH domains of the Fc region. Truncated forms of such polypeptides containing the hinge region that promotes dimerization are also included. Preferred Fc polypeptides comprise an Fc polypeptide derived from a human IgG1 antibody. As one alternative, an oligomer is prepared using polypeptides derived from immunoglobulins. Preparation of fusion polypeptides comprising certain heterologous polypeptides fused to various portions of antibody-derived polypeptides (including the Fc domain) has been described, *e.g.*, by 15 Ashkenazi et al. (*PNAS USA* 88:10535, 1991); Byrn et al. (*Nature* 344:677, 1990); and Hollenbaugh and Aruffo ("Construction of Immunoglobulin Fusion Polypeptides", in *Current Protocols in Immunology*, Suppl. 4, pages 10.19.1 - 10.19.11, 1992). Methods for preparation and use of immunoglobulin-based oligomers are well known in the art. One embodiment of the present invention is directed to a dimer comprising two fusion polypeptides created by fusing a polypeptide of the invention to an Fc polypeptide derived from an antibody. A gene fusion encoding the polypeptide/Fc fusion polypeptide is inserted into an appropriate expression vector. Polypeptide/Fc fusion polypeptides are expressed in host cells transformed with the recombinant expression vector, and allowed to assemble much like antibody molecules, whereupon interchain disulfide bonds form 20 between the Fc moieties to yield divalent molecules. One suitable Fc polypeptide, described in PCT application WO 93/10151, is a single chain polypeptide extending from the N-terminal hinge region to the native C-terminus of the Fc region of a human IgG1 antibody. Another useful Fc polypeptide is the Fc mutein described in U.S. Patent 5,457,035 and in Baum et al., (*EMBO J.* 13:3992-4001, 1994). The amino acid sequence of this mutein is identical to that of the native Fc sequence presented in WO 93/10151, except that amino acid 19 has been changed from Leu to Ala, amino acid 20 has been changed from Leu to Glu, and amino acid 22 has been changed from Gly to Ala. The mutein exhibits reduced affinity for Fc receptors. The above-described fusion polypeptides comprising Fc moieties (and oligomers formed therefrom) offer the advantage of facile purification by affinity chromatography over Polypeptide A or Polypeptide G columns. In other embodiments, the polypeptides of the invention can be substituted for the variable portion of an antibody heavy or light chain. If fusion polypeptides are made with both heavy and light chains of an antibody, it is possible to form an oligomer with as many as four HPR1 and/or HPR2 extracellular regions. 35

Peptide-linker Based Oligomers. Alternatively, the oligomer is a fusion polypeptide comprising multiple HPR1 and/or HPR2 polypeptides, with or without peptide linkers (spacer peptides). Among the suitable peptide linkers are those described in U.S. Patents 4,751,180 and 4,935,233. A DNA sequence encoding a desired peptide linker can be inserted between, and in the same reading frame as, the DNA sequences of the invention, using any suitable conventional technique. 40

5 For example, a chemically synthesized oligonucleotide encoding the linker can be ligated between the sequences. In particular embodiments, a fusion polypeptide comprises from two to four soluble HPR1 and/or HPR2 polypeptides, separated by peptide linkers. Suitable peptide linkers, their combination with other polypeptides, and their use are well known by those skilled in the art.

10 Leucine-Zippers. Another method for preparing the oligomers of the invention involves use of a leucine zipper. Leucine zipper domains are peptides that promote oligomerization of the polypeptides in which they are found. Leucine zippers were originally identified in several DNA-binding polypeptides (Landschulz et al., *Science* 240:1759, 1988), and have since been found in a variety of different polypeptides. Among the known leucine zippers are naturally occurring peptides and derivatives thereof that dimerize or trimerize. The zipper domain (also referred to herein as an  
15 oligomerizing, or oligomer-forming, domain) comprises a repetitive heptad repeat, often with four or five leucine residues interspersed with other amino acids. Use of leucine zippers and preparation of oligomers using leucine zippers are well known in the art.

Other fragments and derivatives of the sequences of polypeptides which would be expected to retain polypeptide activity in whole or in part and may thus be useful for screening or other  
20 immunological methodologies can also be made by those skilled in the art given the disclosures herein. Such modifications are believed to be encompassed by the present invention.

#### **Nucleic Acids Encoding HPR1 Polypeptides and Nucleic Acids Encoding HPR2 Polypeptides**

Encompassed within the invention are nucleic acids encoding HPR1 polypeptides and nucleic  
25 acids encoding HPR2 polypeptides. These nucleic acids can be identified in several ways, including isolation of genomic or cDNA molecules from a suitable source. Nucleotide sequences corresponding to the amino acid sequences described herein, to be used as probes or primers for the isolation of nucleic acids or as query sequences for database searches, can be obtained by "back-translation" from the amino acid sequences, or by identification of regions of amino acid identity with polypeptides for  
30 which the coding DNA sequence has been identified. The well-known polymerase chain reaction (PCR) procedure can be employed to isolate and amplify a DNA sequence encoding an HPR1 or HPR2 polypeptide or a desired combination of HPR1 and/or HPR2 polypeptide fragments. Oligonucleotides that define the desired termini of the combination of DNA fragments are employed as 5' and 3' primers. The oligonucleotides can additionally contain recognition sites for restriction endonucleases, to  
35 facilitate insertion of the amplified combination of DNA fragments into an expression vector. PCR techniques are described in Saiki et al., *Science* 239:487 (1988); *Recombinant DNA Methodology*, Wu et al., eds., Academic Press, Inc., San Diego (1989), pp. 189-196; and *PCR Protocols: A Guide to Methods and Applications*, Innis et al., eds., Academic Press, Inc. (1990).

40 Nucleic acid molecules of the invention include DNA and RNA in both single-stranded and double-stranded form, as well as the corresponding complementary sequences. DNA includes, for example, cDNA, genomic DNA, chemically synthesized DNA, DNA amplified by PCR, and combinations thereof. The nucleic acid molecules of the invention include full-length genes or cDNA

5 molecules as well as a combination of fragments thereof. The nucleic acids of the invention are preferentially derived from human sources, but the invention includes those derived from non-human species, as well.

10 An "isolated nucleic acid" is a nucleic acid that has been separated from adjacent genetic sequences present in the genome of the organism from which the nucleic acid was isolated, in the case of nucleic acids isolated from naturally-occurring sources. In the case of nucleic acids synthesized enzymatically from a template or chemically, such as PCR products, cDNA molecules, or oligonucleotides for example, it is understood that the nucleic acids resulting from such processes are isolated nucleic acids. An isolated nucleic acid molecule refers to a nucleic acid molecule in the form of a separate fragment or as a component of a larger nucleic acid construct. In one preferred  
15 embodiment, the invention relates to certain isolated nucleic acids that are substantially free from contaminating endogenous material. The nucleic acid molecule has preferably been derived from DNA or RNA isolated at least once in substantially pure form and in a quantity or concentration enabling identification, manipulation, and recovery of its component nucleotide sequences by standard biochemical methods (such as those outlined in Sambrook et al., *Molecular Cloning: A Laboratory Manual*, 2nd ed., Cold Spring Harbor Laboratory, Cold Spring Harbor, NY (1989)). Such sequences  
20 are preferably provided and/or constructed in the form of an open reading frame uninterrupted by internal non-translated sequences, or introns, that are typically present in eukaryotic genes. Sequences of non-translated DNA can be present 5' or 3' from an open reading frame, where the same do not interfere with manipulation or expression of the coding region.

25 "An isolated nucleic acid consisting essentially of a nucleotide sequence" means that the nucleic acid may have, in addition to said nucleotide sequence, additional material covalently linked to either or both ends of the nucleic acid molecule, said additional material preferably between 1 and 100,000 additional nucleotides covalently linked to either end, each end, or both ends of the nucleic acid molecule, and more preferably between 1 and 1,000 additional nucleotides covalently linked to  
30 either end, each end, or both ends of the nucleic acid molecule, and most preferably between 10 and 100 additional nucleotides covalently linked to either end, each end, or both ends of the nucleic acid molecule. In preferred embodiments, covalent linkage of additional nucleotides to either end, each end, or both ends of the nucleic acid molecule results in a novel combined nucleotide sequence that is neither naturally occurring nor disclosed in the art. An isolated nucleic acid consisting essentially of a  
35 nucleotide sequence may be an expression vector or other construct comprising said nucleotide sequence.

The present invention also includes nucleic acids that hybridize under moderately stringent conditions, and more preferably highly stringent conditions, to nucleic acids encoding HPR1 polypeptides and/or nucleic acids encoding HPR2 polypeptides described herein. The basic parameters  
40 affecting the choice of hybridization conditions and guidance for devising suitable conditions are set forth by Sambrook, Fritsch, and Maniatis (1989, *Molecular Cloning: A Laboratory Manual*, Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y., chapters 9 and 11; and *Current Protocols*

5 in Molecular Biology, 1995, Ausubel et al., eds., John Wiley & Sons, Inc., sections 2.10 and 6.3-6.4), and can be readily determined by those having ordinary skill in the art based on, for example, the length and/or base composition of the DNA. One way of achieving moderately stringent conditions involves the use of a prewashing solution containing 5 x SSC, 0.5% SDS, 1.0 mM EDTA (pH 8.0), hybridization buffer of about 50% formamide, 6 x SSC, and a hybridization temperature of about 55  
10 degrees C (or other similar hybridization solutions, such as one containing about 50% formamide, with a hybridization temperature of about 42 degrees C), and washing conditions of about 60 degrees C, in 0.5 x SSC, 0.1% SDS. Generally, highly stringent conditions are defined as hybridization conditions as above, but with washing at approximately 68 degrees C, 0.2 x SSC, 0.1% SDS. SSPE (1xSSPE is 0.15M NaCl, 10 mM NaH.sub.2 PO.sub.4, and 1.25 mM EDTA, pH 7.4) can be substituted for SSC  
15 (1xSSC is 0.15M NaCl and 15 mM sodium citrate) in the hybridization and wash buffers; washes are performed for 15 minutes after hybridization is complete. It should be understood that the wash temperature and wash salt concentration can be adjusted as necessary to achieve a desired degree of stringency by applying the basic principles that govern hybridization reactions and duplex stability, as known to those skilled in the art and described further below (see, e.g., Sambrook et al., 1989). When  
20 hybridizing a nucleic acid to a target nucleic acid of unknown sequence, the hybrid length is assumed to be that of the hybridizing nucleic acid. When nucleic acids of known sequence are hybridized, the hybrid length can be determined by aligning the sequences of the nucleic acids and identifying the region or regions of optimal sequence complementarity. The hybridization temperature for hybrids anticipated to be less than 50 base pairs in length should be 5 to 10 degrees C less than the melting  
25 temperature (T<sub>m</sub>) of the hybrid, where T<sub>m</sub> is determined according to the following equations. For hybrids less than 18 base pairs in length, T<sub>m</sub> (degrees C) = 2(# of A + T bases) + 4(# of #G + C bases). For hybrids above 18 base pairs in length, T<sub>m</sub> (degrees C) = 81.5 + 16.6(log<sub>10</sub> [Na<sup>+</sup>]) + 0.41(% G + C) - (600/N), where N is the number of bases in the hybrid, and [Na<sup>+</sup>] is the concentration of sodium ions in the hybridization buffer ([Na<sup>+</sup>] for 1xSSC = 0.165M). Preferably, each such hybridizing nucleic acid  
30 has a length that is at least 15 nucleotides (or more preferably at least 18 nucleotides, or at least 20 nucleotides, or at least 25 nucleotides, or at least 30 nucleotides, or at least 40 nucleotides, or most preferably at least 50 nucleotides), or at least 25% (more preferably at least 50%, or at least 60%, or at least 70%, and most preferably at least 80%) of the length of the nucleic acid of the present invention to which it hybridizes, and has at least 60% sequence identity (more preferably at least 70%, at least 75%,  
35 at least 80%, at least 85%, at least 90%, at least 95%, at least 97.5%, or at least 99%, and most preferably at least 99.5%) with the nucleic acid of the present invention to which it hybridizes, where sequence identity is determined by comparing the sequences of the hybridizing nucleic acids when aligned so as to maximize overlap and identity while minimizing sequence gaps as described in more detail above.

40 The present invention also provides genes corresponding to the nucleic acid sequences disclosed herein. "Corresponding genes" or "corresponding genomic nucleic acids" are the regions of the genome that are transcribed to produce the mRNAs from which cDNA nucleic acid sequences are

5 derived and can include contiguous regions of the genome necessary for the regulated expression of such genes. Corresponding genes can therefore include but are not limited to coding sequences, 5' and 3' untranslated regions, alternatively spliced exons, introns, promoters, enhancers, and silencer or suppressor elements. Corresponding genomic nucleic acids can include 10000 basepairs (more preferably, 5000 basepairs, still more preferably, 2500 basepairs, and most preferably, 1000 basepairs) of genomic nucleic acid sequence upstream of the first nucleotide of the genomic sequence corresponding to the initiation codon of the HPR1 coding sequence or of the HPR2 coding sequence, and 10000 basepairs (more preferably, 5000 basepairs, still more preferably, 2500 basepairs, and most preferably, 1000 basepairs) of genomic nucleic acid sequence downstream of the last nucleotide of the genomic sequence corresponding to the termination codon of the HPR1 coding sequence or of the HPR2 coding sequence. The corresponding genes or genomic nucleic acids can be isolated in accordance with known methods using the sequence information disclosed herein. Such methods include the preparation of probes or primers from the disclosed sequence information for identification and/or amplification of genes in appropriate genomic libraries or other sources of genomic materials. An "isolated gene" or an "isolated genomic nucleic acid" is a genomic nucleic acid that has been separated from the adjacent genomic sequences present in the genome of the organism from which the genomic nucleic acid was isolated.

#### Methods for Making and Purifying HPR1 and HPR2 Polypeptides

25 Methods for making HPR1 and HPR2 polypeptides are described below. Expression, isolation, and purification of the polypeptides and fragments of the invention can be accomplished by any suitable technique, including but not limited to the following methods. The isolated nucleic acid of the invention can be operably linked to an expression control sequence such as the pDC409 vector (Giri *et al.*, 1990, *EMBO J.*, 13: 2821) or the derivative pDC412 vector (Wiley *et al.*, 1995, *Immunity* 3: 673). The pDC400 series vectors are useful for transient mammalian expression systems, such as CV-1 or 293 cells. Alternatively, the isolated nucleic acid of the invention can be linked to expression vectors such as pDC312, pDC316, or pDC317 vectors, which are useful for stable mammalian expression systems, such as CHO cells or their derivatives. Other expression control sequences and cloning technologies can also be used to produce the polypeptide recombinantly, such as the pMT2 or pED expression vectors (Kaufman *et al.*, 1991, *Nucleic Acids Res.* 19: 4485-4490; and Pouwels *et al.*, 1985, *Cloning Vectors: A Laboratory Manual*, Elsevier, New York) and the GATEWAY Vectors (lifetech.com/Content/Tech-Online/molecular\_biology/manuals\_pps/11797016.pdf; Life Technologies; Rockville, MD). Many suitable expression control sequences are known in the art. General methods of expressing recombinant polypeptides are also known and are exemplified in R. Kaufman, *Methods in Enzymology* 185, 537-566 (1990). As used herein "operably linked" means that the nucleic acid of the invention and an expression control sequence are situated within a construct, vector, or cell in such a way that the polypeptide encoded by the nucleic acid is expressed when appropriate molecules (such as polymerases) are present. As one embodiment of the invention, at least one expression control

5 sequence is operably linked to the nucleic acid of the invention in a recombinant host cell or progeny thereof, the nucleic acid and/or expression control sequence having been introduced into the host cell by transformation or transfection, for example, or by any other suitable method. As another embodiment of the invention, at least one expression control sequence is integrated into the genome of a recombinant host cell such that it is operably linked to a nucleic acid sequence encoding a polypeptide of the invention. In a further embodiment of the invention, at least one expression control sequence is operably linked to a nucleic acid of the invention through the action of a trans-acting factor such as a transcription factor, either *in vitro* or in a recombinant host cell.

In addition, a sequence encoding an appropriate signal peptide (native or heterologous) can be incorporated into expression vectors. The choice of signal peptide or leader can depend on factors such as the type of host cells in which the recombinant polypeptide is to be produced. To illustrate, examples of heterologous signal peptides that are functional in mammalian host cells include the signal sequence for interleukin-7 (IL-7) described in United States Patent 4,965,195; the signal sequence for interleukin-2 receptor described in Cosman et al., *Nature* 312:768 (1984); the interleukin-4 receptor signal peptide described in EP 367,566; the type I interleukin-1 receptor signal peptide described in U.S. Patent 4,968,607; and the type II interleukin-1 receptor signal peptide described in EP 460,846. A DNA sequence for a signal peptide (secretory leader) can be fused in frame to the nucleic acid sequence of the invention so that the DNA is initially transcribed, and the mRNA translated, into a fusion polypeptide comprising the signal peptide. A signal peptide that is functional in the intended host cells promotes extracellular secretion of the polypeptide. The signal peptide is cleaved from the polypeptide upon secretion of polypeptide from the cell. The skilled artisan will also recognize that the position(s) at which the signal peptide is cleaved can differ from that predicted by computer program, and can vary according to such factors as the type of host cells employed in expressing a recombinant polypeptide. A polypeptide preparation can include a mixture of polypeptide molecules having different N-terminal amino acids, resulting from cleavage of the signal peptide at more than one site.

Established methods for introducing DNA into mammalian cells have been described (Kaufman, R.J., *Large Scale Mammalian Cell Culture*, 1990, pp. 15-69). Additional protocols using commercially available reagents, such as Lipofectamine lipid reagent (Gibco/BRL) or Lipofectamine-Plus lipid reagent, can be used to transfect cells (Felgner et al., *Proc. Natl. Acad. Sci. USA* 84:7413-7417, 1987). In addition, electroporation can be used to transfect mammalian cells using conventional procedures, such as those in Sambrook et al. (*Molecular Cloning: A Laboratory Manual*, 2 ed. Vol. 1-3, Cold Spring Harbor Laboratory Press, 1989). Selection of stable transformants can be performed using methods known in the art, such as, for example, resistance to cytotoxic drugs. Kaufman et al., *Meth. in Enzymology* 185:487-511, 1990, describes several selection schemes, such as dihydrofolate reductase (DHFR) resistance. A suitable strain for DHFR selection can be CHO strain DX-B11, which is deficient in DHFR (Urlaub and Chasin, *Proc. Natl. Acad. Sci. USA* 77:4216-4220, 1980). Other examples of selectable markers that can be incorporated into an expression vector include cDNAs

5 conferring resistance to antibiotics, such as G418 and hygromycin B. Cells harboring the vector can be selected on the basis of resistance to these compounds.

Alternatively, gene products can be obtained via homologous recombination, or "gene targeting," techniques. Such techniques employ the introduction of exogenous transcription control elements (such as the CMV promoter or the like) in a particular predetermined site on the genome, to  
10 induce expression of the endogenous nucleic acid sequence of interest (see, for example, U.S. Patent No. 5,272,071). The location of integration into a host chromosome or genome can be easily determined by one of skill in the art, given the known location and sequence of the gene. In a preferred embodiment, the present invention also contemplates the introduction of exogenous transcriptional control elements in conjunction with an amplifiable gene, to produce increased amounts of the gene  
15 product, again, without the need for isolation of the gene sequence itself from the host cell.

A number of types of cells can act as suitable host cells for expression of the polypeptide. Mammalian host cells include, for example, the COS-7 line of monkey kidney cells (ATCC CRL 1651) (Gluzman et al., *Cell* 23:175, 1981), L cells, C127 cells, 3T3 cells (ATCC CCL 163), Chinese hamster ovary (CHO) cells, HeLa cells, BHK (ATCC CRL 10) cell lines, the CV1/EBNA cell line derived from  
20 the African green monkey kidney cell line CV1 (ATCC CCL 70) as described by McMahan et al. (*EMBO J.* 10: 2821, 1991), human kidney 293 cells, human epidermal A431 cells, human Colo205 cells, other transformed primate cell lines, normal diploid cells, cell strains derived from in vitro culture of primary tissue, primary explants, HL-60, U937, HaK or Jurkat cells. Alternatively, it is possible to produce the polypeptide in lower eukaryotes such as yeast or in prokaryotes such as bacteria.  
25 Potentially suitable yeasts include *Saccharomyces cerevisiae*, *Schizosaccharomyces pombe*, *Kluyveromyces* strains, *Candida*, or any yeast strain capable of expressing heterologous polypeptides. Potentially suitable bacterial strains include *Escherichia coli*, *Bacillus subtilis*, *Salmonella typhimurium*, or any bacterial strain capable of expressing heterologous polypeptides. If the polypeptide is made in yeast or bacteria, it may be necessary to modify the polypeptide produced  
30 therein, for example by phosphorylation or glycosylation of the appropriate sites, in order to obtain the functional polypeptide. Such covalent attachments can be accomplished using known chemical or enzymatic methods. The polypeptide can also be produced by operably linking the isolated nucleic acid of the invention to suitable control sequences in one or more insect expression vectors, and employing an insect expression system. Materials and methods for baculovirus/insect cell expression  
35 systems are commercially available in kit form from, e.g., Invitrogen, San Diego, Calif., U.S.A. (the MaxBac® kit), and such methods are well known in the art, as described in Summers and Smith, Texas Agricultural Experiment Station Bulletin No. 1555 (1987), and Luckow and Summers, *Bio/Technology* 6:47 (1988). Cell-free translation systems could also be employed to produce polypeptides using  
40 RNAs derived from nucleic acid constructs disclosed herein. A host cell that comprises an isolated nucleic acid of the invention, preferably operably linked to at least one expression control sequence, is a "recombinant host cell".

5           The polypeptide of the invention can be prepared by culturing transformed host cells under culture conditions suitable to express the recombinant polypeptide. The resulting expressed polypeptide can then be purified from such culture (i.e., from culture medium or cell extracts) using known purification processes, such as gel filtration and ion exchange chromatography. The purification of the polypeptide can also include an affinity column containing agents which will bind to the polypeptide; one or more column steps over such affinity resins as concanavalin A-agarose, heparin-toyopearl® or Cibacrom blue 3GA Sepharose®; one or more steps involving hydrophobic interaction chromatography using such resins as phenyl ether, butyl ether, or propyl ether; or immunoaffinity chromatography. Alternatively, the polypeptide of the invention can also be expressed in a form which will facilitate purification. For example, it can be expressed as a fusion polypeptide, such as those of maltose binding polypeptide (MBP), glutathione-S-transferase (GST) or thioredoxin (TRX). Kits for expression and purification of such fusion polypeptides are commercially available from New England BioLab (Beverly, Mass.), Pharmacia (Piscataway, N.J.) and InVitrogen, respectively. The polypeptide can also be tagged with an epitope and subsequently purified by using a specific antibody directed to such epitope. One such epitope (FLAG®) is commercially available from Kodak (New Haven, Conn.). Finally, one or more reverse-phase high performance liquid chromatography (RP-HPLC) steps employing hydrophobic RP-HPLC media, e.g., silica gel having pendant methyl or other aliphatic groups, can be employed to further purify the polypeptide. Some or all of the foregoing purification steps, in various combinations, can also be employed to provide a substantially homogeneous isolated recombinant polypeptide. The polypeptide thus purified is substantially free of other mammalian polypeptides and is defined in accordance with the present invention as an "isolated polypeptide"; such isolated polypeptides of the invention include isolated antibodies that bind to HPR1 and/or HPR2 polypeptides, fragments, variants, binding partners etc. The polypeptide of the invention can also be expressed as a product of transgenic animals, e.g., as a component of the milk of transgenic cows, goats, pigs, or sheep which are characterized by somatic or germ cells containing a nucleotide sequence encoding the polypeptide.

          It is also possible to utilize an affinity column comprising a polypeptide-binding polypeptide of the invention, such as a monoclonal antibody generated against polypeptides of the invention, to affinity-purify expressed polypeptides. These polypeptides can be removed from an affinity column using conventional techniques, e.g., in a high salt elution buffer and then dialyzed into a lower salt buffer for use or by changing pH or other components depending on the affinity matrix utilized, or be competitively removed using the naturally occurring substrate of the affinity moiety, such as a polypeptide derived from the invention. In this aspect of the invention, polypeptide-binding polypeptides, such as the anti-polypeptide antibodies of the invention or other polypeptides that can interact with the polypeptide of the invention, can be bound to a solid phase support such as a column chromatography matrix or a similar substrate suitable for identifying, separating, or purifying cells that express polypeptides of the invention on their surface. Adherence of polypeptide-binding polypeptides of the invention to a solid phase contacting surface can be accomplished by any means, for example,



5 magnetic microspheres can be coated with these polypeptide-binding polypeptides and held in the incubation vessel through a magnetic field. Suspensions of cell mixtures are contacted with the solid phase that has such polypeptide-binding polypeptides thereon. Cells having polypeptides of the invention on their surface bind to the fixed polypeptide-binding polypeptide and unbound cells then are washed away. This affinity-binding method is useful for purifying, screening, or separating such  
10 polypeptide-expressing cells from solution. Methods of releasing positively selected cells from the solid phase are known in the art and encompass, for example, the use of enzymes. Such enzymes are preferably non-toxic and non-injurious to the cells and are preferably directed to cleaving the cell-surface binding partner. Alternatively, mixtures of cells suspected of containing polypeptide-expressing cells of the invention first can be incubated with a biotinylated polypeptide-binding  
15 polypeptide of the invention. The resulting mixture then is passed through a column packed with avidin-coated beads, whereby the high affinity of biotin for avidin provides the binding of the polypeptide-binding cells to the beads. Use of avidin-coated beads is known in the art. See Berenson, et al. *J. Cell. Biochem.*, 10D:239 (1986). Wash of unbound material and the release of the bound cells is performed using conventional methods.

20 The polypeptide can also be produced by known conventional chemical synthesis. The synthetically-constructed polypeptide sequences, by virtue of sharing primary, secondary or tertiary structural and/or conformational characteristics with HPR1 and/or HPR2 polypeptides can possess biological properties in common therewith, including HPR1 and/or HPR2 polypeptide activity. Thus, they can be employed as biologically active or immunological substitutes for natural, purified  
25 polypeptides in screening of therapeutic compounds and in immunological processes for the development of antibodies.

The desired degree of purity depends on the intended use of the polypeptide. A relatively high degree of purity is desired when the polypeptide is to be administered *in vivo*, for example. In such a case, the polypeptides are purified such that no polypeptide bands corresponding to other polypeptides  
30 are detectable upon analysis by SDS-polyacrylamide gel electrophoresis (SDS-PAGE). It will be recognized by one skilled in the pertinent field that multiple bands corresponding to the polypeptide can be visualized by SDS-PAGE, due to differential glycosylation, differential post-translational processing, and the like. Most preferably, the polypeptide of the invention is purified to substantial homogeneity, as indicated by a single polypeptide band upon analysis by SDS-PAGE. The polypeptide  
35 band can be visualized by silver staining, Coomassie blue staining, or (if the polypeptide is radiolabeled) by autoradiography.

#### **Antagonists and Agonists of HPR1 and/or HPR2 Polypeptides**

Any method which neutralizes HPR1 and/or HPR2 polypeptides or inhibits expression of the HPR1 and/or HPR2 genes (either transcription or translation) can be used to reduce the biological  
40 activities of HPR1 and/or HPR2 polypeptides. In particular embodiments, antagonists inhibit the binding of at least one HPR1 polypeptide and/or at least one HPR2 polypeptide to cells, thereby inhibiting biological activities induced by the binding of those HPR1 or HPR2 polypeptides to the

5 cells. In certain other embodiments of the invention, antagonists can be designed to reduce the level of endogenous HPR1 and/or HPR2 gene expression, *e.g.*, using well-known antisense or ribozyme approaches to inhibit or prevent translation of HPR1 and/or HPR2 mRNA transcripts; triple helix approaches to inhibit transcription of HPR1 and/or HPR2 genes; or targeted homologous recombination to inactivate or "knock out" the HPR1 gene(s), the HPR2 gene(s), or their endogenous  
10 promoters or enhancer elements. Such antisense, ribozyme, and triple helix antagonists can be designed to reduce or inhibit either unimpaired, or if appropriate, mutant HPR1 and/or HPR2 gene activity. Techniques for the production and use of such molecules are well known to those of skill in the art.

Antisense RNA and DNA molecules act to directly block the translation of mRNA by  
15 hybridizing to targeted mRNA and preventing polypeptide translation. Antisense approaches involve the design of oligonucleotides (either DNA or RNA) that are complementary to an HPR1 and/or to an HPR2 mRNA. The antisense oligonucleotides will bind to the complementary target gene mRNA transcripts and prevent translation. Absolute complementarity, although preferred, is not required. A sequence "complementary" to a portion of a nucleic acid, as referred to herein, means a sequence  
20 having sufficient complementarity to be able to hybridize with the nucleic acid, forming a stable duplex (or triplex, as appropriate). In the case of double-stranded antisense nucleic acids, a single strand of the duplex DNA can thus be tested, or triplex formation can be assayed. The ability to hybridize will depend on both the degree of complementarity and the length of the antisense nucleic acid. Preferred oligonucleotides are complementary to the 5' end of the message, *e.g.*, the 5' untranslated sequence up  
25 to and including the AUG initiation codon. However, oligonucleotides complementary to the 5'- or 3'-non-translated, non-coding regions of the HPR1 or HPR2 gene transcript(s) could be used in an antisense approach to inhibit translation of endogenous HPR1 and/or HPR2 mRNA. Antisense nucleic acids should be at least six nucleotides in length, and are preferably oligonucleotides ranging from 6 to about 50 nucleotides in length. In specific aspects the oligonucleotide is at least 10 nucleotides, at least  
30 17 nucleotides, at least 25 nucleotides or at least 50 nucleotides. The oligonucleotides can be DNA or RNA or chimeric mixtures or derivatives or modified versions thereof, single-stranded or double-stranded. Chimeric oligonucleotides, oligonucleosides, or mixed oligonucleotides/oligonucleosides of the invention can be of several different types. These include a first type wherein the "gap" segment of nucleotides is positioned between 5' and 3' "wing" segments of linked nucleosides and a second "open  
35 end" type wherein the "gap" segment is located at either the 3' or the 5' terminus of the oligomeric compound (*see, e.g.*, U.S. Pat. No. 5,985,664). Oligonucleotides of the first type are also known in the art as "gapmers" or gapped oligonucleotides. Oligonucleotides of the second type are also known in the art as "hemimers" or "wingmers". The oligonucleotide can be modified at the base moiety, sugar moiety, or phosphate backbone, for example, to improve stability of the molecule, hybridization, etc.  
40 The oligonucleotide can include other appended groups such as peptides (*e.g.*, for targeting host cell receptors *in vivo*), or agents facilitating transport across the cell membrane (*see, e.g.*, Letsinger *et al.*, 1989, *Proc Natl Acad Sci USA* 86:6553-6556; Lemaitre *et al.*, 1987, *Proc Natl Acad Sci* 84:648-652;

5 PCT Publication No. WO88/09810), or hybridization-triggered cleavage agents or intercalating agents. (See, *e.g.*, Zon, 1988, Pharm. Res. 5:539-549). The antisense molecules should be delivered to cells which express the HPR1 and/or HPR2 transcript in vivo. A number of methods have been developed for delivering antisense DNA or RNA to cells; *e.g.*, antisense molecules can be injected directly into the tissue or cell derivation site, or modified antisense molecules, designed to target the desired cells  
10 (*e.g.*, antisense linked to peptides or antibodies that specifically bind receptors or antigens expressed on the target cell surface) can be administered systemically. However, it is often difficult to achieve intracellular concentrations of the antisense sufficient to suppress translation of endogenous mRNAs. Therefore a preferred approach utilizes a recombinant DNA construct in which the antisense oligonucleotide is placed under the control of a strong pol III or pol II promoter. The use of such a  
15 construct to transfect target cells in the patient will result in the transcription of sufficient amounts of single stranded RNAs that will form complementary base pairs with the endogenous HPR1 and/or HPR2 gene transcripts and thereby prevent translation of the HPR1 and/or HPR2 mRNA. For example, a vector can be introduced in vivo such that it is taken up by a cell and directs the transcription of an antisense RNA. Such a vector can remain episomal or become chromosomally  
20 integrated, as long as it can be transcribed to produce the desired antisense RNA. Such vectors can be constructed by recombinant DNA technology methods standard in the art. Vectors can be plasmid, viral, or others known in the art, used for replication and expression in mammalian cells.

Ribozyme molecules designed to catalytically cleave HPR1 and/or HPR2 mRNA transcripts can also be used to prevent translation of HPR1 and/or HPR2 mRNA and expression of HPR1 and/or  
25 HPR2 polypeptides. (See, *e.g.*, PCT International Publication WO90/11364 and US Patent No. 5,824,519). The ribozymes that can be used in the present invention include hammerhead ribozymes (Haseloff and Gerlach, 1988, Nature, 334:585-591), RNA endoribonucleases (hereinafter "Cech-type ribozymes") such as the one which occurs naturally in Tetrahymena Thermophila (known as the IVS, or L-19 IVS RNA) and which has been extensively described by Thomas Cech and collaborators  
30 (International Patent Application No. WO 88/04300; Been and Cech, 1986, Cell, 47:207-216). As in the antisense approach, the ribozymes can be composed of modified oligonucleotides (*e.g.* for improved stability, targeting, etc.) and should be delivered to cells which express HPR1 and/or HPR2 polypeptides in vivo. A preferred method of delivery involves using a DNA construct "encoding" the ribozyme under the control of a strong constitutive pol III or pol II promoter, so that transfected cells  
35 will produce sufficient quantities of the ribozyme to destroy endogenous HPR1 and/or HPR2 messages and inhibit translation. Because ribozymes, unlike antisense molecules, are catalytic, a lower intracellular concentration is required for efficiency.

Alternatively, endogenous HPR1 and/or HPR2 gene expression can be reduced by targeting deoxyribonucleotide sequences complementary to the regulatory region of the target gene (*i.e.*, the  
40 target gene promoter and/or enhancers) to form triple helical structures that prevent transcription of the target HPR1 and/or HPR2 gene. (See generally, Helene, 1991, Anticancer Drug Des., 6(6), 569-584; Helene, et al., 1992, Ann. N.Y. Acad. Sci., 660, 27-36; and Maher, 1992, Bioassays 14(12), 807-815).

5 Anti-sense RNA and DNA, ribozyme, and triple helix molecules of the invention can be prepared by any method known in the art for the synthesis of DNA and RNA molecules. These include techniques for chemically synthesizing oligodeoxyribonucleotides and oligoribonucleotides well known in the art such as for example solid phase phosphoramidite chemical synthesis. Oligonucleotides can be synthesized by standard methods known in the art, *e.g.* by use of an automated  
10 DNA synthesizer (such as are commercially available from Biosearch, Applied Biosystems, etc.). As examples, phosphorothioate oligonucleotides can be synthesized by the method of Stein *et al.*, 1988, Nucl. Acids Res. 16:3209. Methylphosphonate oligonucleotides can be prepared by use of controlled pore glass polymer supports (Sarin *et al.*, 1988, Proc. Natl. Acad. Sci. U.S.A. 85:7448-7451). Alternatively, RNA molecules can be generated by in vitro and in vivo transcription of DNA sequences  
15 encoding the antisense RNA molecule. Such DNA sequences can be incorporated into a wide variety of vectors that incorporate suitable RNA polymerase promoters such as the T7 or SP6 polymerase promoters. Alternatively, antisense cDNA constructs that synthesize antisense RNA constitutively or inducibly, depending on the promoter used, can be introduced stably into cell lines.

Endogenous target gene expression can also be reduced by inactivating or "knocking out" the  
20 target gene or its promoter using targeted homologous recombination (*e.g.*, see Smithies, *et al.*, 1985, Nature 317, 230-234; Thomas and Capecchi, 1987, Cell 51, 503-512; Thompson, *et al.*, 1989, Cell 5, 313-321). For example, a mutant, non-functional target gene (or a completely unrelated DNA sequence) flanked by DNA homologous to the endogenous target gene (either the coding regions or regulatory regions of the target gene) can be used, with or without a selectable marker and/or a negative  
25 selectable marker, to transfect cells that express the target gene in vivo. Insertion of the DNA construct, via targeted homologous recombination, results in inactivation of the target gene. Such approaches are particularly suited in the agricultural field where modifications to ES (embryonic stem) cells can be used to generate animal offspring with an inactive target gene (*e.g.*, see Thomas and Capecchi, 1987 and Thompson, 1989, *supra*), or in model organisms such as *Caenorhabditis elegans*  
30 where the "RNA interference" ("RNAi") technique (Grishok, Tabara, and Mello, 2000, Genetic requirements for inheritance of RNAi in *C. elegans*, Science 287 (5462): 2494-2497), or the introduction of transgenes (Dernburg *et al.*, 2000, Transgene-mediated cosuppression in the *C. elegans* germ line, Genes Dev. 14 (13): 1578-1583) are used to inhibit the expression of specific target genes. However this approach can be adapted for use in humans provided the recombinant DNA constructs  
35 are directly administered or targeted to the required site in vivo using appropriate vectors such as viral vectors.

Organisms that have enhanced, reduced, or modified expression of the gene(s) corresponding to the nucleic acid sequences disclosed herein are provided. The desired change in gene expression can be achieved through the use of antisense nucleic acids or ribozymes that bind and/or cleave the mRNA  
40 transcribed from the gene (Albert and Morris, 1994, Trends Pharmacol. Sci. 15(7): 250-254; Lavarosky *et al.*, 1997, Biochem. Mol. Med. 62(1): 11-22; and Hampel, 1998, Prog. Nucleic Acid Res. Mol. Biol. 58: 1-39). Transgenic animals that have multiple copies of the gene(s) corresponding to the nucleic

5 acid sequences disclosed herein, preferably produced by transformation of cells with genetic constructs that are stably maintained within the transformed cells and their progeny, are provided. Transgenic animals that have modified genetic control regions that increase or reduce gene expression levels, or that change temporal or spatial patterns of gene expression, are also provided (see European Patent No. 0 649 464 B1). In addition, organisms are provided in which the gene(s) corresponding to the nucleic acid sequences disclosed herein have been partially or completely inactivated, through insertion of  
10 extraneous sequences into the corresponding gene(s) or through deletion of all or part of the corresponding gene(s). Partial or complete gene inactivation can be accomplished through insertion, preferably followed by imprecise excision, of transposable elements (Plasterk, 1992, *Bioessays* 14(9): 629-633; Zwaal et al., 1993, *Proc Natl Acad Sci USA* 90(16): 7431-7435; Clark et al., 1994, *Proc Natl Acad Sci USA* 91(2): 719-722), or through homologous recombination, preferably detected by  
15 positive/negative genetic selection strategies (Mansour et al., 1988, *Nature* 336: 348-352; U.S. Pat. Nos. 5,464,764; 5,487,992; 5,627,059; 5,631,153; 5,614,396; 5,616,491; and 5,679,523). These organisms with altered gene expression are preferably eukaryotes and more preferably are mammals. Such organisms are useful for the development of non-human models for the study of disorders  
20 involving the corresponding gene(s), and for the development of assay systems for the identification of molecules that interact with the polypeptide product(s) of the corresponding gene(s).

Also encompassed within the invention are HPR1 and HPR2 polypeptide variants with partner binding sites that have been altered in conformation so that (1) the HPR1 or HPR2 variant will still bind to its partner(s), but a specified small molecule will fit into the altered binding site and block that  
25 interaction, or (2) the HPR1 or HPR2 variant will no longer bind to its partner(s) unless a specified small molecule is present (see for example Bishop *et al.*, 2000, *Nature* 407: 395-401). Nucleic acids encoding such altered HPR1 or HPR2 polypeptides can be introduced into organisms according to methods described herein, and can replace the endogenous nucleic acid sequences encoding the corresponding HPR1 or HPR2 polypeptide. Such methods allow for the interaction of a particular  
30 HPR1 or HPR2 polypeptide with its binding partners to be regulated by administration of a small molecule compound to an organism, either systemically or in a localized manner.

The HPR1 and HPR2 polypeptides themselves can also be employed in inhibiting a biological activity of HPR1 and /or of HPR2 in *in vitro* or *in vivo* procedures. Encompassed within the invention are cytokine receptor domains of HPR1 and HPR2 polypeptides that act as "dominant negative"  
35 inhibitors of native HPR1 and/or HPR2 polypeptide function when expressed as fragments or as components of fusion polypeptides. For example, a purified polypeptide domain of the present invention can be used to inhibit binding of HPR1 or HPR2 polypeptides to endogenous binding partners. Such use effectively would block HPR1 and/or HPR2 polypeptide interactions and inhibit HPR1 and/or HPR2 polypeptide activities. In still another aspect of the invention, a soluble form of an  
40 HPR1 and/or HPR2 binding partner is used to bind to an endogenous HPR1 and/or HPR2 polypeptide, and competitively inhibit activation of that endogenous HPR1 and/or HPR2 polypeptide. Furthermore, antibodies which bind to HPR1 and/or HPR2 polypeptides often inhibit HPR1 and/or HPR2

5 polypeptide activity and act as antagonists. For example, antibodies that specifically recognize one or more epitopes of HPR1 and/or HPR2 polypeptides, or epitopes of conserved variants of HPR1 and/or HPR2 polypeptides, or peptide fragments of an HPR1 and/or HPR2 polypeptide can be used in the invention to inhibit HPR1 and/or HPR2 polypeptide activity. Such antibodies include but are not limited to polyclonal antibodies, monoclonal antibodies (mAbs), humanized or chimeric antibodies, 10 single chain antibodies, Fab fragments, F(ab')<sub>2</sub> fragments, fragments produced by a Fab expression library, anti-idiotypic (anti-Id) antibodies, and epitope-binding fragments of any of the above. Alternatively, purified and modified HPR1 and/or HPR2 polypeptides of the present invention can be administered to modulate interactions between HPR1 and/or HPR2 polypeptides and HPR1 and/or HPR2 binding partners that are not membrane-bound. Such an approach will allow an alternative 15 method for the modification of HPR1- and/or HPR2-influenced bioactivity.

In an alternative aspect, the invention further encompasses the use of agonists of HPR1 and/or HPR2 polypeptide activity to treat or ameliorate the symptoms of a disease for which increased HPR1 and/or HPR2 polypeptide activity is beneficial. Such diseases include but are not limited to pancytopenia, leukopenia, anemia, thrombocytopenia, neurodegenerative disorders, osteoporosis 20 resulting from a lack of bone-forming cells, obesity, deficient mammary development, and infertility. In a preferred aspect, the invention entails administering compositions comprising an HPR1 or HPR2 nucleic acid or an HPR1 or HPR2 polypeptide to cells *in vitro*, to cells *ex vivo*, to cells *in vivo*, and/or to a multicellular organism such as a vertebrate or mammal. Preferred therapeutic forms of HPR1 and HPR2 are soluble forms, as described above. In still another aspect of the invention, the compositions 25 comprise administering an HPR1-encoding nucleic acid or an HPR2-encoding nucleic acid for expression of an HPR1 or HPR2 polypeptide in a host organism for treatment of disease. Particularly preferred in this regard is expression in a human patient for treatment of a dysfunction associated with aberrant (*e.g.*, decreased) endogenous activity of an HPR1 or HPR2 polypeptide. Furthermore, the invention encompasses the administration to cells and/or organisms of compounds found to increase 30 the endogenous activity of HPR1 and/or HPR2 polypeptides. One example of compounds that increase HPR1 and/or HPR2 polypeptide activity are agonistic antibodies, preferably monoclonal antibodies, that bind to HPR1 and/or HPR2 polypeptides or binding partners, which may increase HPR1 and/or HPR2 polypeptide activity by causing constitutive intracellular signaling (or "ligand mimicking"), or by preventing the binding of a native inhibitor of HPR1 and/or HPR2 polypeptide activity.

#### 35 **Antibodies to HPR1 and/or HPR2 Polypeptides**

Antibodies that are immunoreactive with the polypeptides of the invention are provided herein. Such antibodies specifically bind to the polypeptides via the antigen-binding sites of the antibody (as opposed to non-specific binding). In the present invention, specifically binding antibodies 40 are those that will specifically recognize and bind with HPR1 and/or HPR2 polypeptides, homologues, and variants, but not with other molecules. In one preferred embodiment, the antibodies are specific for

5 the polypeptides of the present invention and do not cross-react with other polypeptides. In this manner, the HPR1 and HPR2 polypeptides, fragments, variants, fusion polypeptides, etc., as set forth above can be employed as "immunogens" in producing antibodies immunoreactive therewith.

More specifically, the polypeptides, fragment, variants, fusion polypeptides, etc. contain antigenic determinants or epitopes that elicit the formation of antibodies. These antigenic determinants or epitopes can be either linear or conformational (discontinuous). Linear epitopes are composed of a single section of amino acids of the polypeptide, while conformational or discontinuous epitopes are composed of amino acids sections from different regions of the polypeptide chain that are brought into close proximity upon polypeptide folding (Janeway and Travers, *Immuno Biology* 3:9 (Garland Publishing Inc., 2nd ed. 1996)). Because folded polypeptides have complex surfaces, the number of epitopes available is quite numerous; however, due to the conformation of the polypeptide and steric hinderances, the number of antibodies that actually bind to the epitopes is less than the number of available epitopes (Janeway and Travers, *Immuno Biology* 2:14 (Garland Publishing Inc., 2nd ed. 1996)). Epitopes can be identified by any of the methods known in the art. Thus, one aspect of the present invention relates to the antigenic epitopes of the polypeptides of the invention. Such epitopes are useful for raising antibodies, in particular monoclonal antibodies, as described in more detail below. Additionally, epitopes from the polypeptides of the invention can be used as research reagents, in assays, and to purify specific binding antibodies from substances such as polyclonal sera or supernatants from cultured hybridomas. Such epitopes or variants thereof can be produced using techniques well known in the art such as solid-phase synthesis, chemical or enzymatic cleavage of a polypeptide, or using recombinant DNA technology.

As to the antibodies that can be elicited by the epitopes of the polypeptides of the invention, whether the epitopes have been isolated or remain part of the polypeptides, both polyclonal and monoclonal antibodies can be prepared by conventional techniques. See, for example, *Monoclonal Antibodies, Hybridomas: A New Dimension in Biological Analyses*, Kennet et al. (eds.), Plenum Press, New York (1980); and *Antibodies: A Laboratory Manual*, Harlow and Land (eds.), Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY, (1988); Kohler and Milstein, (U.S. Pat. No. 4,376,110); the human B-cell hybridoma technique (Kosbor et al., 1984, *J Immunol* 133: 3001-3005; Cole et al., 1983, *Proc Natl Acad Sci USA* 80:2026-2030); and the EBV-hybridoma technique (Cole et al., 1985, *Monoclonal Antibodies And Cancer Therapy*, Alan R. Liss, Inc., pp. 77-96). Hybridoma cell lines that produce monoclonal antibodies specific for the polypeptides of the invention are also contemplated herein. Such hybridomas can be produced and identified by conventional techniques. The hybridoma producing the mAb of this invention can be cultivated in vitro or in vivo. Production of high titers of mAbs in vivo makes this the presently preferred method of production. One method for producing such a hybridoma cell line comprises immunizing an animal with a polypeptide; harvesting spleen cells from the immunized animal; fusing said spleen cells to a myeloma cell line, thereby generating hybridoma cells; and identifying a hybridoma cell line that produces a monoclonal antibody that binds the polypeptide. For the production of antibodies, various host animals can be immunized by

5 injection with one or more of the following: an HPR1 or HPR2 polypeptide, a fragment of an HPR1 or  
HPR2 polypeptide, a functional equivalent of an HPR1 or HPR2 polypeptide, or a mutant form of an  
HPR1 or HPR2 polypeptide. Such host animals can include but are not limited to rabbits, mice, and  
rats. Various adjuvants can be used to increase the immunologic response, depending on the host  
10 species, including but not limited to Freund's (complete and incomplete), mineral gels such as  
aluminum hydroxide, surface active substances such as lysolecithin, pluronic polyols, polyanions,  
peptides, oil emulsions, keyhole limpet hemocyanin, dinitrophenol, and potentially useful human  
adjuvants such as BCG (bacille Calmette-Guerin) and *Corynebacterium parvum*. The monoclonal  
antibodies can be recovered by conventional techniques. Such monoclonal antibodies can be of any  
immunoglobulin class including IgG, IgM, IgE, IgA, IgD and any subclass thereof.

15 In addition, techniques developed for the production of "chimeric antibodies" (Takeda *et al.*,  
1985, *Nature*, 314: 452-454; Morrison *et al.*, 1984, *Proc Natl Acad Sci USA* 81: 6851-6855; Boulianne  
*et al.*, 1984, *Nature* 312: 643-646; Neuberger *et al.*, 1985, *Nature* 314: 268-270) by splicing the genes  
from a mouse antibody molecule of appropriate antigen specificity together with genes from a human  
antibody molecule of appropriate biological activity can be used. A chimeric antibody is a molecule in  
20 which different portions are derived from different animal species, such as those having a variable  
region derived from a porcine mAb and a human immunoglobulin constant region. The monoclonal  
antibodies of the present invention also include humanized versions of murine monoclonal antibodies.  
Such humanized antibodies can be prepared by known techniques and offer the advantage of reduced  
immunogenicity when the antibodies are administered to humans. In one embodiment, a humanized  
25 monoclonal antibody comprises the variable region of a murine antibody (or just the antigen binding  
site thereof) and a constant region derived from a human antibody. Alternatively, a humanized  
antibody fragment can comprise the antigen binding site of a murine monoclonal antibody and a  
variable region fragment (lacking the antigen-binding site) derived from a human antibody. Procedures  
for the production of chimeric and further engineered monoclonal antibodies include those described in  
30 Riechmann *et al.* (*Nature* 332:323, 1988), Liu *et al.* (*PNAS* 84:3439, 1987), Larrick *et al.*  
(*Bio/Technology* 7:934, 1989), and Winter and Harris (*TIPS* 14:139, Can, 1993). Useful techniques for  
humanizing antibodies are also discussed in U.S. Patent 6,054,297. Procedures to generate antibodies  
transgenically can be found in GB 2,272,440, US Patent Nos. 5,569,825 and 5,545,806, and related  
patents. Preferably, for use in humans, the antibodies are human or humanized; techniques for creating  
35 such human or humanized antibodies are also well known and are commercially available from, for  
example, Medarex Inc. (Princeton, NJ) and Abgenix Inc. (Fremont, CA). In another preferred  
embodiment, fully human antibodies for use in humans are produced by screening a phage display  
library of human antibody variable domains (Vaughan *et al.*, 1998, *Nat Biotechnol.* 16(6): 535-539;  
and U.S. Patent No. 5,969,108).

40 Antigen-binding antibody fragments which recognize specific epitopes can be generated by  
known techniques. For example, such fragments include but are not limited to: the F(ab')<sub>2</sub> fragments  
which can be produced by pepsin digestion of the antibody molecule and the Fab fragments which can



5 be generated by reducing the disulfide bridges of the (ab')<sub>2</sub> fragments. Alternatively, Fab expression libraries can be constructed (Huse *et al.*, 1989, *Science*, 246:1275-1281) to allow rapid and easy identification of monoclonal Fab fragments with the desired specificity. Techniques described for the production of single chain antibodies (U.S. Pat. No. 4,946,778; Bird, 1988, *Science* 242:423-426; Huston *et al.*, 1988, *Proc. Natl. Acad. Sci. USA* 85:5879-5883; and Ward *et al.*, 1989, *Nature* 334:544-10 546) can also be adapted to produce single chain antibodies against HPR1 and/or HPR2 gene products. Single chain antibodies are formed by linking the heavy and light chain fragments of the Fv region via an amino acid bridge, resulting in a single chain polypeptide. Such single chain antibodies can also be useful intracellularly (i.e., as 'intrabodies), for example as described by Marasco *et al.* (*J. Immunol. Methods* 231:223-238, 1999) for genetic therapy in HIV infection. In addition, antibodies to the HPR1 and/or HPR2 polypeptide can, in turn, be utilized to generate anti-idiotypic antibodies that "mimic" the15 HPR1 and/or HPR2 polypeptide and that may bind to the binding partner(s) of HPR1 and/or HPR2 polypeptides, using techniques well known to those skilled in the art. (See, *e.g.*, Greenspan & Bona, 1993, *FASEB J* 7(5):437-444; and Nissinoff, 1991, *J. Immunol.* 147(8):2429-2438).

Antibodies that are immunoreactive with the polypeptides of the invention include bispecific20 antibodies (i.e., antibodies that are immunoreactive with the polypeptides of the invention via a first antigen binding domain, and also immunoreactive with a different polypeptide via a second antigen binding domain). A variety of bispecific antibodies have been prepared, and found useful both *in vitro* and *in vivo* (see, for example, U.S. Patent 5,807,706; and Cao and Suresh, 1998, *Bioconjugate Chem* 9: 635-644). Numerous methods of preparing bispecific antibodies are known in the art, including the use25 of hybrid-hybridomas such as quadromas, which are formed by fusing two differed hybridomas, and triomas, which are formed by fusing a hybridoma with a lymphocyte (Milstein and Cuello, 1983, *Nature* 305: 537-540; U.S. Patent 4,474,893; and U.S. Patent 6,106,833). U.S. Patent 6,060,285 discloses a process for the production of bispecific antibodies in which at least the genes for the light chain and the variable portion of the heavy chain of an antibody having a first specificity are30 transfected into a hybridoma cell secreting an antibody having a second specificity. Chemical coupling of antibody fragments has also been used to prepare antigen-binding molecules having specificity for two different antigens (Brennan *et al.*, 1985, *Science* 229: 81-83; Glennie *et al.*, *J. Immunol.*, 1987, 139:2367-2375; and U.S. Patent 6,010,902). Bispecific antibodies can also be produced via recombinant means, for example, by using the leucine zipper moieties from the *Fos* and *Jun* proteins35 (which preferentially form heterodimers) as described by Kostelny *et al.* (*J. Immunol.* 148:1547-4553; 1992). U.S. Patent 5,582,996 discloses the use of complementary interactive domains (such as leucine zipper moieties or other lock and key interactive domain structures) to facilitate heterodimer formation in the production of bispecific antibodies. Tetravalent, bispecific molecules can be prepared by fusion of DNA encoding the heavy chain of an F(ab')<sub>2</sub> fragment of an antibody with either DNA encoding the40 heavy chain of a second F(ab')<sub>2</sub> molecule (in which the CH1 domain is replaced by a CH3 domain), or with DNA encoding a single chain FV fragment of an antibody, as described in U.S. Patent 5,959,083. Expression of the resultant fusion genes in mammalian cells, together with the genes for the

5 corresponding light chains, yields tetravalent bispecific molecules having specificity for selected antigens. Bispecific antibodies can also be produced as described in U.S. Patent 5,807,706. Generally, the method involves introducing a protuberance (constructed by replacing small amino acid side chains with larger side chains) at the interface of a first polypeptide and a corresponding cavity (prepared by replacing large amino acid side chains with smaller ones) in the interface of a second polypeptide.

10 Moreover, single-chain variable fragments (sFvs) have been prepared by covalently joining two variable domains; the resulting antibody fragments can form dimers or trimers, depending on the length of a flexible linker between the two variable domains (Kortt *et al.*, 1997, *Protein Engineering* 10:423-433).

Screening procedures by which such antibodies can be identified are well known, and can

15 involve immunoaffinity chromatography, for example. Antibodies can be screened for agonistic (*i.e.*, ligand-mimicking) properties. Such antibodies, upon binding to cell surface HPR1 and/or HPR2, induce biological effects (e.g., transduction of biological signals) similar to the biological effects induced when the HPR1 and/or HPR2 binding partner binds to cell surface HPR1 and/or HPR2. Agonistic antibodies can be used to induce HPR1- and/or HPR2-mediated intracellular signaling or cell

20 proliferation. Bispecific antibodies can be identified by screening with two separate assays, or with an assay wherein the bispecific antibody serves as a bridge between the first antigen and the second antigen (the latter is coupled to a detectable moiety). Bispecific antibodies that bind HPR1 and/or HPR2 polypeptides of the invention via a first antigen binding domain will be useful in diagnostic applications and in treating cell proliferation, differentiation, or activation diseases or conditions.

25 Examples of polypeptides (or other antigens) that the inventive bispecific antibodies bind via a second antigen binding domain include: four alpha helix bundle cytokines such as IL-6, OSM, LIF, CNTF, CLC, IL-12p35, and IL-23p19; soluble hematopoietin receptors such as EBI-3, soluble IL-6R alpha, cytokine-like factor-1 (CLF), IL-12p40, or a soluble form of HPR1 and/or HPR2; and soluble hematopoietin receptors such as EBI-3 etc. in conjunction with a four alpha helix bundle cytokine.

30 Those antibodies that can block binding of the HPR1 and/or HPR2 polypeptides of the invention to binding partners for HPR1 and/or HPR2 can be used to inhibit HPR1- and/or HPR2-mediated intracellular signaling or cell proliferation that results from such binding. Such blocking antibodies can be identified using any suitable assay procedure, such as by testing antibodies for the ability to inhibit binding of HPR1 and/or HPR2 to certain cells expressing an HPR1 and/or HPR2

35 binding partner. Alternatively, blocking antibodies can be identified in assays for the ability to inhibit a biological effect that results from binding of soluble HPR1 and/or HPR2 to target cells. Antibodies can be assayed for the ability to inhibit HPR1 and/or HPR2 binding partner-mediated cell stimulatory pathways, for example. Such an antibody can be employed in an *in vitro* procedure, or administered *in vivo* to inhibit a biological activity mediated by the entity that generated the antibody. Disorders

40 caused or exacerbated (directly or indirectly) by the interaction of HPR1 and/or HPR2 with cell surface binding partner receptor thus can be treated. A therapeutic method involves *in vivo* administration of a blocking antibody to a mammal in an amount effective in inhibiting HPR1 and/or HPR2 binding

5 partner-mediated biological activity. Monoclonal antibodies are generally preferred for use in such therapeutic methods. In one embodiment, an antigen-binding antibody fragment is employed. Compositions comprising an antibody that is directed against HPR1 and/or HPR2, and a physiologically acceptable diluent, excipient, or carrier, are provided herein. Suitable components of such compositions are as described below for compositions containing HPR1 and/or HPR2 polypeptides.

10 Also provided herein are conjugates comprising a detectable (e.g., diagnostic) or therapeutic agent, attached to the antibody. Examples of such agents are presented above. The conjugates find use in *in vitro* or *in vivo* procedures. The antibodies of the invention can also be used in assays to detect the presence of the polypeptides or fragments of the invention, either *in vitro* or *in vivo*. The antibodies also can be employed in purifying polypeptides or fragments of the invention by immunoaffinity chromatography.

#### **Rational Design of Compounds that Interact with HPR1 and/or HPR2 Polypeptides**

The goal of rational drug design is to produce structural analogs of biologically active polypeptides of interest or of small molecules with which they interact, e.g., inhibitors, agonists, antagonists, etc. Any of these examples can be used to fashion drugs which are more active or stable forms of the polypeptide or which enhance or interfere with the function of a polypeptide in vivo (Hodgson J (1991) Biotechnology 9:19-21). In one approach, the three-dimensional structure of a polypeptide of interest, or of a polypeptide-inhibitor complex, is determined by x-ray crystallography, by nuclear magnetic resonance, or by computer homology modeling or, most typically, by a combination of these approaches. Both the shape and charges of the polypeptide must be ascertained to elucidate the structure and to determine active site(s) of the molecule. Less often, useful information regarding the structure of a polypeptide may be gained by modeling based on the structure of homologous polypeptides. In both cases, relevant structural information is used to design analogous HPR1- and/or HPR2-like molecules, to identify efficient inhibitors, or to identify small molecules that bind HPR1 and/or HPR2 polypeptides. Useful examples of rational drug design include molecules which have improved activity or stability as shown by Braxton S and Wells JA (1992 Biochemistry 31:7796-7801) or which act as inhibitors, agonists, or antagonists of native peptides as shown by Athauda SB et al (1993 J Biochem 113:742-746). The use of HPR1 and/or HPR2 polypeptide structural information in molecular modeling software systems to assist in inhibitor design and in studying inhibitor-HPR1 polypeptide and/or inhibitor-HPR2 polypeptide interaction is also encompassed by the invention. A particular method of the invention comprises analyzing the three-dimensional structure of HPR1 and/or HPR2 polypeptides for likely binding sites of substrates, synthesizing a new molecule that incorporates a predictive reactive site, and assaying the new molecule as described further herein.

40 It is also possible to isolate a target-specific antibody, selected by functional assay, as described further herein, and then to solve its crystal structure. This approach, in principle, yields a pharmacore upon which subsequent drug design can be based. It is possible to bypass polypeptide

5 crystallography altogether by generating anti-idiotypic antibodies (anti-ids) to a functional, pharmacologically active antibody. As a mirror image of a mirror image, the binding site of the anti-ids would be expected to be an analog of the original receptor. The anti-id could then be used to identify and isolate peptides from banks of chemically or biologically produced peptides. The isolated peptides would then act as the pharmacore.

#### 10 **Assays of HPR1 and HPR2 Polypeptide Activities**

The purified HPR1 and HPR2 polypeptides of the invention (including polypeptides, polypeptides, fragments, variants, oligomers, and other forms) are useful in a variety of assays. For example, the HPR1 and HPR2 molecules of the present invention can be used to identify binding partners of HPR1 and/or HPR2 polypeptides, which can also be used to modulate intracellular  
15 signaling, cell proliferation, or immune cell activity. Alternatively, they can be used to identify non-binding-partner molecules or substances that modulate intracellular signaling, cell proliferation, or immune cell activity.

Assays to Identify Binding Partners. HPR1 and HPR2 polypeptides and fragments thereof can be used to identify binding partners. For example, they can be tested for the ability to bind a candidate  
20 binding partner in any suitable assay, such as a conventional binding assay. To illustrate, the HPR1 or HPR2 polypeptide can be labeled with a detectable reagent (*e.g.*, a radionuclide, chromophore, enzyme that catalyzes a colorimetric or fluorometric reaction, and the like). The labeled polypeptide is contacted with cells expressing the candidate binding partner. The cells then are washed to remove unbound labeled polypeptide, and the presence of cell-bound label is determined by a suitable  
25 technique, chosen according to the nature of the label.

One example of a binding assay procedure is as follows. A recombinant expression vector containing the candidate binding partner cDNA is constructed. CV1-EBNA-1 cells in 10 cm<sup>2</sup> dishes are transfected with this recombinant expression vector. CV-1/EBNA-1 cells (ATCC CRL 10478) constitutively express EBV nuclear antigen-1 driven from the CMV Immediate-early  
30 enhancer/promoter. CV1-EBNA-1 was derived from the African Green Monkey kidney cell line CV-1 (ATCC CCL 70), as described by McMahan *et al.*, (*EMBO J.* 10:2821, 1991). The transfected cells are cultured for 24 hours, and the cells in each dish then are split into a 24-well plate. After culturing an additional 48 hours, the transfected cells (about 4 x 10<sup>4</sup> cells/well) are washed with BM-NFDM, which is binding medium (RPMI 1640 containing 25 mg/ml bovine serum albumin, 2 mg/ml sodium azide, 20  
35 mM Hepes pH 7.2) to which 50 mg/ml nonfat dry milk has been added. The cells then are incubated for 1 hour at 37°C with various concentrations of, for example, a soluble polypeptide/Fc fusion polypeptide made as set forth above. Cells then are washed and incubated with a constant saturating concentration of a <sup>125</sup>I-mouse anti-human IgG in binding medium, with gentle agitation for 1 hour at 37°C. After extensive washing, cells are released *via* trypsinization. The mouse anti-human IgG  
40 employed above is directed against the Fc region of human IgG and can be obtained from Jackson ImmunoResearch Laboratories, Inc., West Grove, PA. The antibody is radioiodinated using the standard chloramine-T method. The antibody will bind to the Fc portion of any polypeptide/Fc

5 polypeptide that has bound to the cells. In all assays, non-specific binding of  $^{125}\text{I}$ -antibody is assayed in the absence of the Fc fusion polypeptide/Fc, as well as in the presence of the Fc fusion polypeptide and a 200-fold molar excess of unlabeled mouse anti-human IgG antibody. Cell-bound  $^{125}\text{I}$ -antibody is quantified on a Packard Autogamma counter. Affinity calculations (Scatchard, *Ann. N.Y. Acad. Sci.* 51:660, 1949) are generated on RS/1 (BBN Software, Boston, MA) run on a Microvax computer.

10 Binding can also be detected using methods that are well suited for high-throughput screening procedures, such as scintillation proximity assays (Udenfriend *et al.*, 1985, *Proc Natl Acad Sci USA* 82: 8672-8676), homogeneous time-resolved fluorescence methods (Park *et al.*, 1999, *Anal Biochem* 269: 94-104), fluorescence resonance energy transfer (FRET) methods (Clegg RM, 1995, *Curr Opin Biotechnol* 6: 103-110), or methods that measure any changes in surface plasmon resonance when a

15 bound polypeptide is exposed to a potential binding partner, using for example a biosensor such as that supplied by Biacore AB (Uppsala, Sweden). Compounds that can be assayed for binding to HPR1 and/or HPR2 polypeptides include but are not limited to small organic molecules, such as those that are commercially available - often as part of large combinatorial chemistry compound 'libraries' - from companies such as Sigma-Aldrich (St. Louis, MO), Arqual (Woburn, MA), EnzyMed (Iowa City, IA),

20 Maybridge Chemical Co.(Trevillet, Cornwall, UK), MDS Panlabs (Bothell, WA), Pharmacopeia (Princeton, NJ), and Trega (San Diego, CA). Preferred small organic molecules for screening using these assays are usually less than 10K molecular weight and can possess a number of physicochemical and pharmacological properties which enhance cell penetration, resist degradation, and/or prolong their physiological half-lives (Gibbs, J., 1994, *Pharmaceutical Research in Molecular Oncology, Cell* 79(2):

25 193-198). Compounds including natural products, inorganic chemicals, and biologically active materials such as proteins and toxins can also be assayed using these methods for the ability to bind to HPR1 and/or HPR2 polypeptides.

Yeast Two-Hybrid or "Interaction Trap" Assays. Because HPR1 and HPR2 polypeptides bind or potentially bind to another polypeptide (such as, for example, in a receptor-ligand interaction), the

30 nucleic acid encoding the HPR1 or HPR2 polypeptide can also be used in interaction trap assays (such as, for example, that described in Gyuris *et al.*, *Cell* 75:791-803 (1993)) to identify nucleic acids encoding the other polypeptide with which binding occurs, or to identify inhibitors of the binding interaction. Polypeptides involved in these binding interactions can also be used to screen for peptide or small molecule inhibitors or agonists of the binding interaction.

35 Competitive Binding Assays. Another type of suitable binding assay is a competitive binding assay. To illustrate, biological activity of a variant can be determined by assaying for the variant's ability to compete with the native polypeptide for binding to the candidate binding partner. Competitive binding assays can be performed by conventional methodology. Reagents that can be employed in competitive binding assays include radiolabeled HPR1 or HPR2 and intact cells

40 expressing HPR1 and/or HPR2 (endogenous or recombinant) on the cell surface. For example, a radiolabeled soluble HPR1 or HPR2 fragment can be used to compete with a soluble HPR1 variant and/or a soluble HPR2 variant for binding to cell surface receptors. Instead of intact cells, one could

5 substitute a soluble binding partner/Fc fusion polypeptide bound to a solid phase through the interaction of Polypeptide A or Polypeptide G (on the solid phase) with the Fc moiety. Chromatography columns that contain Polypeptide A and Polypeptide G include those available from Pharmacia Biotech, Inc., Piscataway, NJ.

Assays to Identify Modulators of Intracellular Signaling, Cell Proliferation, or Immune Cell

10 Activity. The influence of HPR1 or HPR2 on intracellular signaling, cell proliferation, or immune cell activity can be manipulated to control these activities in target cells. For example, the disclosed HPR1 and HPR2 polypeptides, nucleic acids encoding the disclosed HPR1 and HPR2 polypeptides, or agonists or antagonists of such polypeptides can be administered to a cell or group of cells to induce, enhance, suppress, or arrest intracellular signaling or cell proliferation by the target cells. Identification  
15 of HPR1 and HPR2 polypeptides, agonists or antagonists that can be used in this manner can be carried out *via* a variety of assays known to those skilled in the art. Included in such assays are those that evaluate the ability of an HPR1 or HPR2 polypeptide to influence intracellular signaling, cell proliferation, or immune cell activity. Such an assay would involve, for example, the analysis of immune cell interaction in the presence of an HPR1 polypeptide and/or an HPR1 polypeptide. In such  
20 an assay, one would determine a rate of intracellular signaling or cell proliferation in the presence of the HPR1 and/or HPR2 polypeptide and then determine if such intracellular signaling or cell proliferation is altered in the presence of a candidate agonist or antagonist or another HPR1 or HPR2 polypeptide. Exemplary assays for this aspect of the invention include cytokine secretion assays, cell proliferation assays, and mixed lymphocyte reactions involving antigen presenting cells and T cells.  
25 These assays are well known to those skilled in the art.

In another aspect, the present invention provides a method of detecting the ability of a test compound to affect the intracellular signaling or cell proliferation activity of a cell. In this aspect, the method comprises: (1) contacting a first group of target cells with a test compound including an HPR1 polypeptide and/or an HPR2 polypeptide, or a fragment or fragments thereof, under conditions  
30 appropriate to the particular assay being used; (2) measuring the net rate of intracellular signaling or cell proliferation among the target cells; and (3) observing the net rate of intracellular signaling or cell proliferation among control cells contacting the HPR1 and/or HPR2 polypeptides or fragments thereof, in the absence of a test compound, under otherwise identical conditions as the first group of cells. In this embodiment, the net rate of intracellular signaling or cell proliferation in the control cells is  
35 compared to that of the cells treated with both a test compound and the HPR1 and/or HPR2 polypeptide(s). The comparison will provide a difference in the net rate of intracellular signaling or cell proliferation such that an effector of intracellular signaling or cell proliferation can be identified. The test compound can function as an effector by either activating or up-regulating, or by inhibiting or down-regulating, intracellular signaling or cell proliferation, and can be detected through this method.

40 Cell Proliferation, Cell Death, Cell Differentiation, and Cell Adhesion Assays. A polypeptide of the present invention may exhibit cytokine, cell proliferation (either inducing or inhibiting), or cell differentiation (either inducing or inhibiting) activity, or may induce production of other cytokines in

5 certain cell populations. Many polypeptide factors discovered to date have exhibited such activity in one or more factor-dependent cell proliferation assays, and hence the assays serve as a convenient confirmation of cell stimulatory activity. The activity of a polypeptide of the present invention is evidenced by any one of a number of routine factor-dependent cell proliferation assays for cell lines including, without limitation, 32D, DA2, DA1G, T10, B9, B9/11, BaF3, MC9/G, M+ (preB M+), 2E8,  
 10 RB5, DA1, 123, T1165, HT2, CTLL2, TF-1, Mo7e and CMK. The activity of an HPR1 or HPR2 polypeptide of the invention may, among other means, be measured by the following methods:

Assays for T-cell or thymocyte proliferation include without limitation those described in: *Current Protocols in Immunology*, Coligan *et al.* eds, Greene Publishing Associates and Wiley-Interscience (pp. 3.1-3.19: *In vitro* assays for mouse lymphocyte function; Chapter 7: Immunologic  
 15 studies in humans); Takai *et al.*, J. Immunol. 137: 3494-3500, 1986; Bertagnolli *et al.*, J. Immunol. 145: 1706-1712, 1990; Bertagnolli *et al.*, Cellular Immunology 133:327-341, 1991; Bertagnolli, *et al.*, J. Immunol. 149:3778-3783, 1992; Bowman *et al.*, J. Immunol. 152: 1756-1761, 1994.

Assays for cytokine production and/or proliferation of spleen cells, lymph node cells or thymocytes include, without limitation, those described in: Kruisbeek and Shevach, 1994, Polyclonal  
 20 T cell stimulation, in *Current Protocols in Immunology*, Coligan *et al.* eds. Vol 1 pp. 3.12.1-3.12.14, John Wiley and Sons, Toronto; and Schreiber, 1994, Measurement of mouse and human interferon gamma in *Current Protocols in Immunology*, Coligan *et al.* eds. Vol 1 pp. 6.8.1-6.8.8, John Wiley and Sons, Toronto.

Assays for proliferation and differentiation of hematopoietic and lymphopoietic cells include, without limitation, those described in: Bottomly *et al.*, 1991, Measurement of human and murine  
 25 interleukin 2 and interleukin 4, in *Current Protocols in Immunology*, Coligan *et al.* eds. Vol 1 pp. 6.3.1-6.3.12, John Wiley and Sons, Toronto; deVries *et al.*, J Exp Med 173: 1205-1211, 1991; Moreau *et al.*, Nature 336:690-692, 1988; Greenberger *et al.*, Proc Natl Acad Sci.USA 80: 2931-2938, 1983; Nordan, 1991, Measurement of mouse and human interleukin 6, in *Current Protocols in Immunology*  
 30 Coligan *et al.* eds. Vol 1 pp. 6.6.1-6.6.5, John Wiley and Sons, Toronto; Smith *et al.*, Proc Natl Acad Sci USA 83: 1857-1861, 1986; Bennett *et al.*, 1991, Measurement of human interleukin 11, in *Current Protocols in Immunology* Coligan *et al.* eds. Vol 1 pp. 6.15.1 John Wiley and Sons, Toronto; Ciarletta *et al.*, 1991, Measurement of mouse and human Interleukin 9, in *Current Protocols in Immunology* Coligan *et al.* eds. Vol 1 pp. 6.13.1, John Wiley and Sons, Toronto.

35 Assays for T-cell clone responses to antigens (which will identify, among others, polypeptides that affect APC-T cell interactions as well as direct T-cell effects by measuring proliferation and cytokine production) include, without limitation, those described in: *Current Protocols in Immunology*, Coligan *et al.* eds, Greene Publishing Associates and Wiley-Interscience (Chapter 3: *In vitro* assays for mouse lymphocyte function; Chapter 6: Cytokines and their cellular receptors; Chapter 7: Immunologic  
 40 studies in humans); Weinberger *et al.*, Proc Natl Acad Sci USA 77: 6091-6095, 1980; Weinberger *et al.*, Eur. J. Immun. 11:405-411, 1981; Takai *et al.*, J. Immunol. 137:3494-3500, 1986; Takai *et al.*, J. Immunol. 140:508-512, 1988

- 5        Assays for thymocyte or splenocyte cytotoxicity include, without limitation, those described in: *Current Protocols in Immunology*, Coligan *et al.* eds, Greene Publishing Associates and Wiley-Interscience (Chapter 3, In Vitro assays for Mouse Lymphocyte Function 3.1-3.19; Chapter 7, Immunologic studies in Humans); Herrmann *et al.*, *Proc. Natl. Acad. Sci. USA* 78:2488-2492, 1981; Herrmann *et al.*, *J. Immunol.* 128:1968-1974, 1982; Handa *et al.*, *J. Immunol.* 135:1564-1572, 1985;
- 10       Takai *et al.*, *J. Immunol.* 137:3494-3500, 1986; Takai *et al.*, *J. Immunol.* 140:508-512, 1988; Herrmann *et al.*, *Proc. Natl. Acad. Sci. USA* 78:2488-2492, 1981; Herrmann *et al.*, *J. Immunol.* 128:1968-1974, 1982; Handa *et al.*, *J. Immunol.* 135:1564-1572, 1985; Takai *et al.*, *J. Immunol.* 137:3494-3500, 1986; Bowman *et al.*, *J. Virology* 61:1992-1998; Takai *et al.*, *J. Immunol.* 140:508-512, 1988; Bertagnolli *et al.*, *Cellular Immunology* 133:327-341, 1991; Brown *et al.*, *J. Immunol.* 153:3079-3092, 1994.
- 15       Assays for T-cell-dependent immunoglobulin responses and isotype switching (which will identify, among others, polypeptides that modulate T-cell dependent antibody responses and that affect Th1/Th2 profiles) include, without limitation, those described in: Maliszewski, *J Immunol* 144: 3028-3033, 1990; and Mond and Brunswick, 1994, Assays for B cell function: *in vitro* antibody production, in *Current Protocols in Immunology* Coligan *et al.* eds. Vol 1 pp. 3.8.1-3.8.16, John Wiley and Sons,
- 20       Toronto.
- Mixed lymphocyte reaction (MLR) assays (which will identify, among others, polypeptides that generate predominantly Th1 and CTL responses) include, without limitation, those described in: *Current Protocols in Immunology*, Coligan *et al.* eds, Greene Publishing Associates and Wiley-Interscience (Chapter 3, In Vitro assays for Mouse Lymphocyte Function 3.1-3.19; Chapter 7,
- 25       Immunologic studies in Humans); Takai *et al.*, *J. Immunol.* 137:3494-3500, 1986; Takai *et al.*, *J. Immunol.* 140:508-512, 1988; Bertagnolli *et al.*, *J. Immunol.* 149:3778-3783, 1992.
- Dendritic cell-dependent assays (which will identify, among others, polypeptides expressed by dendritic cells that activate naive T-cells) include, without limitation, those described in: Guery *et al.*, *J. Immunol* 134:536-544, 1995; Inaba *et al.*, *J Exp Med* 173:549-559, 1991; Macatonia *et al.*, *J Immunol*
- 30       154:5071-5079, 1995; Porgador *et al.*, *J Exp Med* 182:255-260, 1995; Nair *et al.*, *J Virology* 67:4062-4069, 1993; Huang *et al.*, *Science* 264:961-965, 1994; Macatonia *et al.*, *J Exp Med* 169:1255-1264, 1989; Bhardwaj *et al.*, *J Clin Invest* 94:797-807, 1994; and Inaba *et al.*, *J Exp Med* 172:631-640, 1990.
- Assays for lymphocyte survival/apoptosis (which will identify, among others, polypeptides that prevent apoptosis after superantigen induction and polypeptides that regulate lymphocyte homeostasis) include, without limitation, those described in: Darzynkiewicz *et al.*, *Cytometry* 13:795-808, 1992; Gorczyca *et al.*, *Leukemia* 7:659-670, 1993; Gorczyca *et al.*, *Cancer Research* 53:1945-1951, 1993; Itoh *et al.*, *Cell* 66:233-243, 1991; Zacharchuk, *J Immunol* 145:4037-4045, 1990; Zamai *et al.*, *Cytometry* 14:891-897, 1993; Gorczyca *et al.*, *International Journal of Oncology* 1:639-648, 1992.
- 35       Assays for polypeptides that influence early steps of T-cell commitment and development
- 40       include, without limitation, those described in: Antica *et al.*, *Blood* 84:111-117, 1994; Fine *et al.*, *Cell Immunol* 155:111-122, 1994; Galy *et al.*, *Blood* 85:2770-2778, 1995; Toki *et al.*, *Proc Natl Acad Sci. USA* 88:7548-7551, 1991



5        Assays for embryonic stem cell differentiation (which will identify, among others, polypeptides that influence embryonic differentiation hematopoiesis) include, without limitation, those described in: Johansson et al. Cellular Biology 15:141-151, 1995; Keller et al., Molecular and Cellular Biology 13:473-486, 1993; McClanahan et al., Blood 81:2903-2915, 1993.

10        Assays for stem cell survival and differentiation (which will identify, among others, polypeptides that regulate lympho-hematopoiesis) include, without limitation, those described in: Methylcellulose colony forming assays, Freshney, 1994, In *Culture of Hematopoietic Cells*, Freshney et al. eds. pp. 265-268, Wiley-Liss, Inc., New York, NY; Hirayama et al., Proc. Natl. Acad. Sci. USA 89:5907-5911, 1992; Primitive hematopoietic colony forming cells with high proliferative potential, McNiece and Briddell, 1994, In *Culture of Hematopoietic Cells*, Freshney et al. eds. pp. 23-39, Wiley-Liss, Inc., New York, NY; Neben et al., Experimental Hematology 22:353-359, 1994; Ploemacher, 1994, Cobblestone area forming cell assay, In *Culture of Hematopoietic Cells*, Freshney et al. eds. pp. 1-21, Wiley-Liss, Inc., New York, NY; Spooncer et al., 1994, Long term bone marrow cultures in the presence of stromal cells, In *Culture of Hematopoietic Cells*, Freshney et al. eds. pp. 163-179, Wiley-Liss, Inc., New York, NY; Sutherland, 1994, Long term culture initiating cell assay, In *Culture of Hematopoietic Cells*, Freshney et al. eds. Vol pp. 139-162, Wiley-Liss, Inc., New York, NY.

20        Assay for hemostatic and thrombolytic activity include, without limitation, those described in: Linet et al., J. Clin. Pharmacol. 26:131-140, 1986; Burdick et al., Thrombosis Res. 45:413-419, 1987; Humphrey et al., Fibrinolysis 5:71-79 (1991); Schaub, Prostaglandins 35:467-474, 1988.

25        Assays for receptor-ligand activity include without limitation those described in: *Current Protocols in Immunology* Coligan et al. eds, Greene Publishing Associates and Wiley-Interscience (Chapter 7.28, Measurement of cellular adhesion under static conditions 7.28.1-7.28.22), Takai et al., Proc. Natl. Acad. Sci. USA 84:6864-6868, 1987; Bierer et al., J. Exp. Med. 168:1145-1156, 1988; Rosenstein et al., J. Exp. Med. 169:149-160 1989; Stoltenborg et al., J. Immunol. Methods 175:59-68, 1994; Stitt et al., Cell 80:661-670, 1995.

### 30        **Diagnostic and Other Uses of HPR1 and HPR2 Polypeptides and Nucleic Acids**

35        The nucleic acids encoding the HPR1 and HPR2 polypeptides provided by the present invention can be used for numerous diagnostic or other useful purposes. The nucleic acids of the invention can be used to express recombinant polypeptide for analysis, characterization or therapeutic use; as markers for tissues in which the corresponding polypeptide is preferentially expressed (either constitutively or at a particular stage of tissue differentiation or development or in disease states); as molecular weight markers on Southern gels; as chromosome markers or tags (when labeled) to identify chromosomes or to map related gene positions; to compare with endogenous DNA sequences in patients to identify potential genetic disorders; as probes to hybridize and thus discover novel, related DNA sequences; as a source of information to derive PCR primers for genetic fingerprinting; as a probe to "subtract-out" known sequences in the process of discovering other novel nucleic acids; for selecting and making oligomers for attachment to a "gene chip" or other support, including for examination of expression patterns; to raise anti-polypeptide antibodies using DNA immunization

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5 techniques; as an antigen to raise anti-DNA antibodies or elicit another immune response, and, for gene therapy. Uses of HPR1 and HPR2 polypeptides and fragmented polypeptides include, but are not limited to, the following: purifying polypeptides and measuring the activity thereof; delivery agents; therapeutic and research reagents; molecular weight and isoelectric focusing markers; controls for peptide fragmentation; identification of unknown polypeptides; and preparation of antibodies. Any or  
10 all nucleic acids suitable for these uses are capable of being developed into reagent grade or kit format for commercialization as products. Methods for performing the uses listed above are well known to those skilled in the art. References disclosing such methods include without limitation "Molecular Cloning: A Laboratory Manual", 2d ed., Cold Spring Harbor Laboratory Press, Sambrook, J., E. F. Fritsch and T. Maniatis eds., 1989, and "Methods in Enzymology: Guide to Molecular Cloning  
15 Techniques", Academic Press, Berger, S. L. and A. R. Kimmel eds., 1987

Probes and Primers. Among the uses of the disclosed HPR1 and HPR2 nucleic acids, and combinations of fragments thereof, is the use of fragments as probes or primers. Such fragments generally comprise at least about 17 contiguous nucleotides of a DNA sequence. In other embodiments, a DNA fragment comprises at least 30, or at least 60, contiguous nucleotides of a DNA  
20 sequence. The basic parameters affecting the choice of hybridization conditions and guidance for devising suitable conditions are set forth by Sambrook et al., 1989 and are described in detail above. Using knowledge of the genetic code in combination with the amino acid sequences set forth above, sets of degenerate oligonucleotides can be prepared. Such oligonucleotides are useful as primers, e.g., in polymerase chain reactions (PCR), whereby DNA fragments are isolated and amplified. In certain  
25 embodiments, degenerate primers can be used as probes for non-human genetic libraries. Such libraries would include but are not limited to cDNA libraries, genomic libraries, and even electronic EST (express sequence tag) or DNA libraries. Homologous sequences identified by this method would then be used as probes to identify non-human HPR1 and HPR2 homologues.

Chromosome Mapping. The nucleic acids encoding HPR1 and HPR2 polypeptides, and the  
30 disclosed fragments and combinations of these nucleic acids, can be used by those skilled in the art using well-known techniques to identify the human chromosome to which these nucleic acids map. Useful techniques include, but are not limited to, using the sequence or portions, including oligonucleotides, as a probe in various well-known techniques such as radiation hybrid mapping (high resolution), in situ hybridization to chromosome spreads (moderate resolution), and Southern blot  
35 hybridization to hybrid cell lines containing individual human chromosomes (low resolution). Alternatively, the genomic sequences corresponding to nucleic acids encoding a cytokine polypeptide of the invention are mapped by comparison to sequences in public and proprietary databases, such as GenBank (ncbi.nlm.nih.gov/BLAST), Locuslink (ncbi.nlm.nih.gov:80/LocusLink/), Unigene (ncbi.nlm.nih.gov/cgi-bin/UniGene), AceView (ncbi.nlm.nih.gov/AceView), Gene Map Viewer  
40 (ncbi.nlm.nih.gov/genemap), Online Mendelian Inheritance in Man (OMIM) (ncbi.nlm.nih.gov/Omim), and proprietary databases such as the Celera Discovery System (celera.com). These computer analyses of available genomic sequence information can provide the identification of the specific chromosomal

5 location of human and/or murine genomic sequences corresponding to sequences encoding HPR1 or HPR2 polypeptides of the invention, and the unique genetic mapping relationships between HPR1 or HPR2 genomic sequences and the genetic map locations of known human genetic disorders

Diagnostics and Gene Therapy. The nucleic acids encoding HPR1 and HPR2 polypeptides, and the disclosed fragments and combinations of these nucleic acids can be used by one skilled in the art using well-known techniques to analyze abnormalities associated with the genes corresponding to these polypeptides. This enables one to distinguish conditions in which this marker is rearranged or deleted. In addition, nucleic acids of the invention or a fragment thereof can be used as a positional marker to map other genes of unknown location. The DNA can be used in developing treatments for any disorder mediated (directly or indirectly) by defective, or insufficient amounts of, the genes corresponding to the nucleic acids of the invention. Disclosure herein of native nucleotide sequences permits the detection of defective genes, and the replacement thereof with normal genes. Defective genes can be detected in *in vitro* diagnostic assays, and by comparison of a native nucleotide sequence disclosed herein with that of a gene derived from a person suspected of harboring a defect in this gene.

Methods of Screening for Binding Partners. The HPR1 and HPR2 polypeptides of the invention each can be used as reagents in methods to screen for or identify binding partners. For example, the HPR1 and HPR2 polypeptides can be attached to a solid support material and may bind to their binding partners in a manner similar to affinity chromatography. In particular embodiments, a polypeptide is attached to a solid support by conventional procedures. As one example, chromatography columns containing functional groups that will react with functional groups on amino acid side chains of polypeptides are available (Pharmacia Biotech, Inc., Piscataway, NJ). In an alternative, a polypeptide/Fc polypeptide (as discussed above) is attached to Protein A- or Protein G-containing chromatography columns through interaction with the Fc moiety. The HPR1 and HPR2 polypeptides also find use in identifying cells that express a binding partner on the cell surface. Polypeptides are bound to a solid phase such as a column chromatography matrix or a similar suitable substrate. For example, magnetic microspheres can be coated with the polypeptides and held in an incubation vessel through a magnetic field. Suspensions of cell mixtures containing potential binding-partner-expressing cells are contacted with the solid phase having the polypeptides thereon. Cells expressing the binding partner on the cell surface bind to the fixed polypeptides, and unbound cells are washed away. Alternatively, HPR1 and HPR2 polypeptides can be conjugated to a detectable moiety, then incubated with cells to be tested for binding partner expression. After incubation, unbound labeled matter is removed and the presence or absence of the detectable moiety on the cells is determined. In a further alternative, mixtures of cells suspected of expressing the binding partner are incubated with biotinylated polypeptides. Incubation periods are typically at least one hour in duration to ensure sufficient binding. The resulting mixture then is passed through a column packed with avidin-coated beads, whereby the high affinity of biotin for avidin provides binding of the desired cells to the beads. Procedures for using avidin-coated beads are known (see Berenson, et al. *J. Cell. Biochem.*, 10D:239, 1986). Washing to remove unbound material, and the release of the bound cells,

5 are performed using conventional methods. In some instances, the above methods for screening for or identifying binding partners may also be used or modified to isolate or purify such binding partner molecules or cells expressing them.

Measuring Biological Activity. HPR1 and HPR2 polypeptides also find use in measuring the biological activity of HPR1-binding and/or HPR2-binding polypeptides in terms of their binding  
10 affinity. The polypeptides thus can be employed by those conducting "quality assurance" studies, e.g., to monitor shelf life and stability of polypeptide under different conditions. For example, the polypeptides can be employed in a binding affinity study to measure the biological activity of a binding partner polypeptide that has been stored at different temperatures, or produced in different cell types. The polypeptides also can be used to determine whether biological activity is retained after  
15 modification of a binding partner polypeptide (e.g., chemical modification, truncation, mutation, etc.). The binding affinity of the modified polypeptide is compared to that of an unmodified binding polypeptide to detect any adverse impact of the modifications on biological activity of the binding polypeptide. The biological activity of a binding polypeptide thus can be ascertained before it is used in a research study, for example.

20 Carriers and Delivery Agents. The polypeptides also find use as carriers for delivering agents attached thereto to cells bearing identified binding partners. The polypeptides thus can be used to deliver diagnostic or therapeutic agents to such cells (or to other cell types found to express binding partners on the cell surface) in *in vitro* or *in vivo* procedures. Detectable (diagnostic) and therapeutic  
25 agents that can be attached to a polypeptide include, but are not limited to, toxins, other cytotoxic agents, drugs, radionuclides, chromophores, enzymes that catalyze a colorimetric or fluorometric reaction, and the like, with the particular agent being chosen according to the intended application. Among the toxins are ricin, abrin, diphtheria toxin, *Pseudomonas aeruginosa* exotoxin A, ribosomal inactivating polypeptides, mycotoxins such as trichothecenes, and derivatives and fragments (e.g., single chains) thereof. Radionuclides suitable for diagnostic use include, but are not limited to, <sup>123</sup>I,  
30 <sup>131</sup>I, <sup>99m</sup>Tc, <sup>111</sup>In, and <sup>76</sup>Br. Examples of radionuclides suitable for therapeutic use are <sup>131</sup>I, <sup>211</sup>At, <sup>77</sup>Br, <sup>186</sup>Re, <sup>188</sup>Re, <sup>212</sup>Pb, <sup>212</sup>Bi, <sup>109</sup>Pd, <sup>64</sup>Cu, and <sup>67</sup>Cu. Such agents can be attached to the polypeptide by any suitable conventional procedure. The polypeptide comprises functional groups on amino acid side chains that can be reacted with functional groups on a desired agent to form covalent bonds, for example. Alternatively, the polypeptide or agent can be derivatized to generate or attach a desired  
35 reactive functional group. The derivatization can involve attachment of one of the bifunctional coupling reagents available for attaching various molecules to polypeptides (Pierce Chemical Company, Rockford, Illinois). A number of techniques for radiolabeling polypeptides are known. Radionuclide metals can be attached to polypeptides by using a suitable bifunctional chelating agent, for example. Conjugates comprising polypeptides and a suitable diagnostic or therapeutic agent  
40 (preferably covalently linked) are thus prepared. The conjugates are administered or otherwise employed in an amount appropriate for the particular application.

## 5     **Treating Diseases Using HPR1 and/or HPR2 Polypeptides and Antagonists Thereof**

It is anticipated that the HPR1 and HPR2 polypeptides, fragments, variants, antagonists, agonists, antibodies, and binding partners of the invention will be useful for treating medical conditions and diseases including, but not limited to, cell proliferation, metabolic, and reproductive hormone related conditions as described further herein. The therapeutic molecule or molecules to be used will  
10     depend on the etiology of the condition to be treated and the biological pathways involved, and variants, fragments, and binding partners of HPR1 and/or HPR2 polypeptides may have effects similar to or different from HPR1 or HPR2 polypeptides. For example, an antagonist of the ligand-binding activity of HPR1 and/or HPR2 polypeptides may be selected for treatment of conditions involving ligand-binding activity, but a particular fragment of a given HPR1 or HPR2 polypeptide may also act  
15     as an effective dominant negative antagonist of that activity. Therefore, in the following paragraphs “HPR1 and HPR2 polypeptides or antagonists” refers to all HPR1 and HPR2 polypeptides, fragments, variants, antagonists, agonists, antibodies, and binding partners etc. of the invention, and it is understood that a specific molecule or molecules can be selected from those provided as embodiments of the invention by individuals of skill in the art, according to the biological and therapeutic  
20     considerations described herein.

Provided herein are methods for using HPR1 and HPR2 polypeptides or antagonists, compositions or combination therapies to treat various hematologic and oncologic disorders. For example, HPR1 and HPR2 polypeptides or antagonists are used to treat various forms of cancer, including acute myelogenous leukemia, Epstein-Barr virus-positive nasopharyngeal carcinoma, glioma,  
25     colon, stomach, prostate, renal cell, cervical and ovarian cancers, lung cancer (SCLC and NSCLC), including cancer-associated cachexia, fatigue, asthenia, paraneoplastic syndrome of cachexia and hypercalcemia. Additional diseases treatable with the subject HPR1 and HPR2 polypeptides or antagonists, compositions or combination therapies are solid tumors, including sarcoma, osteosarcoma, and carcinoma, such as adenocarcinoma (for example, breast cancer) and squamous cell carcinoma. In  
30     addition, the subject compounds, compositions or combination therapies are useful for treating leukemia, including acute myelogenous leukemia, chronic or acute lymphoblastic leukemia and hairy cell leukemia. Other malignancies with invasive metastatic potential can be treated with the subject compounds, compositions and combination therapies, including multiple myeloma. In addition, the disclosed HPR1 and HPR2 polypeptides or antagonists, compositions and combination therapies can be  
35     used to treat anemias and hematologic disorders, including anemia of chronic disease, aplastic anemia, including Fanconi’s aplastic anemia; idiopathic thrombocytopenic purpura (ITP); myelodysplastic syndromes (including refractory anemia, refractory anemia with ringed sideroblasts, refractory anemia with excess blasts, refractory anemia with excess blasts in transformation); myelofibrosis/myeloid metaplasia; and sickle cell vasocclusive crisis.

40     Various lymphoproliferative disorders also are treatable with the disclosed HPR1 and HPR2 polypeptides or antagonists, compositions or combination therapies. These include, but are not limited to autoimmune lymphoproliferative syndrome (ALPS), chronic lymphoblastic leukemia, hairy cell

5 leukemia, chronic lymphatic leukemia, peripheral T-cell lymphoma, small lymphocytic lymphoma, mantle cell lymphoma, follicular lymphoma, Burkitt's lymphoma, Epstein-Barr virus-positive T cell lymphoma, histiocytic lymphoma, Hodgkin's disease, diffuse aggressive lymphoma, acute lymphatic leukemias, T gamma lymphoproliferative disease, cutaneous B cell lymphoma, cutaneous T cell lymphoma (i.e., mycosis fungoides) and Sézary syndrome.

10 In addition, the subject invention provides HPR1 and HPR2 polypeptides or antagonists, compositions and combination therapies for the treatment of non-arthritic medical conditions of the bones and joints. This encompasses osteoclast disorders that lead to bone loss, such as but not limited to osteoporosis, including post-menopausal osteoporosis, periodontitis resulting in tooth loosening or loss, and prosthesis loosening after joint replacement (generally associated with an inflammatory response to wear debris). This latter condition also is called "orthopedic implant osteolysis." Another condition treatable by administering HPR1 and HPR2 polypeptides or antagonists, is temporal mandibular joint dysfunction (TMJ).

15 The disclosed HPR1 and HPR2 polypeptides or antagonists, compositions and combination therapies furthermore are useful for treating neurodegenerative conditions such as acute polyneuropathy; anorexia nervosa; Bell's palsy; chronic fatigue syndrome; transmissible dementia, including Creutzfeld-Jacob disease; demyelinating neuropathy; Guillain-Barre syndrome; vertebral disc disease; Gulf war syndrome; myasthenia gravis; chronic neuronal degeneration; and stroke, including cerebral ischemic diseases.

## 25 Administration of HPR1 and HPR2 Polypeptides and Antagonists Thereof

This invention provides compounds, compositions, and methods for treating a patient, preferably a mammalian patient, and most preferably a human patient, who is suffering from a medical disorder, and in particular an HPR1- or HPR2-mediated disorder. Such HPR1- or HPR2-mediated disorders include conditions caused (directly or indirectly) or exacerbated by binding between HPR1 and/or HPR2 and a binding partner. For purposes of this disclosure, the terms "illness," "disease," "medical condition," "abnormal condition" and the like are used interchangeably with the term "medical disorder." The terms "treat", "treating", and "treatment" used herein includes curative, preventative (e.g., prophylactic) and palliative or ameliorative treatment. For such therapeutic uses, HPR1 and HPR2 polypeptides and fragments, HPR1 and HPR2 nucleic acids encoding the HPR1 and HPR2 polypeptides, and/or agonists or antagonists of the HPR1 and/or HPR2 polypeptides such as antibodies can be administered to the patient in need through well-known means. Compositions of the present invention can contain a polypeptide in any form described herein, such as native polypeptides, variants, derivatives, oligomers, and biologically active fragments. In particular embodiments, the composition comprises a soluble polypeptide or an oligomer comprising soluble HPR1 and/or HPR2 polypeptides.

40 Therapeutically Effective Amount. In practicing the method of treatment or use of the present invention, a therapeutically effective amount of a therapeutic agent of the present invention is

5 administered to a patient having a condition to be treated, preferably to treat or ameliorate diseases associated with the activity of an HPR1 and/or HPR2 polypeptide. "Therapeutic agent" includes without limitation any of the HPR1 or HPR2 polypeptides, fragments, and variants; nucleic acids encoding the HPR1 and HPR2 polypeptides, fragments, and variants; agonists or antagonists of the HPR1 and HPR2 polypeptides such as antibodies; HPR1 and/or HPR2 polypeptide binding partners; 10 complexes formed from the HPR1 and/or HPR2 polypeptides, fragments, variants, and binding partners, etc. As used herein, the term "therapeutically effective amount" means the total amount of each therapeutic agent or other active component of the pharmaceutical composition or method that is sufficient to show a meaningful patient benefit, i.e., treatment, healing, prevention or amelioration of the relevant medical condition, or an increase in rate of treatment, healing, prevention or amelioration 15 of such conditions. When applied to an individual therapeutic agent or active ingredient, administered alone, the term refers to that ingredient alone. When applied to a combination, the term refers to combined amounts of the ingredients that result in the therapeutic effect, whether administered in combination, serially or simultaneously. As used herein, the phrase "administering a therapeutically effective amount" of a therapeutic agent means that the patient is treated with said therapeutic agent in an amount and for a time sufficient to induce an improvement, and preferably a sustained improvement, in at least one indicator that reflects the severity of the disorder. An improvement is considered "sustained" if the patient exhibits the improvement on at least two occasions separated by one or more weeks. The degree of improvement is determined based on signs or symptoms, and 20 determinations can also employ questionnaires that are administered to the patient, such as quality-of-life questionnaires. Various indicators that reflect the extent of the patient's illness can be assessed for determining whether the amount and time of the treatment is sufficient. The baseline value for the chosen indicator or indicators is established by examination of the patient prior to administration of the first dose of the therapeutic agent. Preferably, the baseline examination is done within about 60 days of administering the first dose. If the therapeutic agent is being administered to treat acute symptoms, the first dose is administered as soon as practically possible after the injury has occurred. Improvement is induced by administering therapeutic agents such as HPR1 and/or HPR2 polypeptides or antagonists until the patient manifests an improvement over baseline for the chosen indicator or indicators. In treating chronic conditions, this degree of improvement is obtained by repeatedly administering this medicament over a period of at least a month or more, e.g., for one, two, or three months or longer, or 25 indefinitely. A period of one to six weeks, or even a single dose, often is sufficient for treating injuries or acute conditions. Although the extent of the patient's illness after treatment may appear improved according to one or more indicators, treatment may be continued indefinitely at the same level or at a reduced dose or frequency. Once treatment has been reduced or discontinued, it later may be resumed at the original level if symptoms should reappear.

30 40 Dosing. One skilled in the pertinent art will recognize that suitable dosages will vary, depending upon such factors as the nature and severity of the disorder to be treated, the patient's body weight, age, general condition, and prior illnesses and/or treatments, and the route of administration.

5 Preliminary doses can be determined according to animal tests, and the scaling of dosages for human administration is performed according to art-accepted practices such as standard dosing trials. For example, the therapeutically effective dose can be estimated initially from cell culture assays. The dosage will depend on the specific activity of the compound and can be readily determined by routine experimentation. A dose can be formulated in animal models to achieve a circulating plasma concentration range that includes the IC<sub>50</sub> (*i.e.*, the concentration of the test compound which achieves a half-maximal inhibition of symptoms) as determined in cell culture, while minimizing toxicities. Such information can be used to more accurately determine useful doses in humans. Ultimately, the attending physician will decide the amount of polypeptide of the present invention with which to treat each individual patient. Initially, the attending physician will administer low doses of polypeptide of the present invention and observe the patient's response. Larger doses of polypeptide of the present invention can be administered until the optimal therapeutic effect is obtained for the patient, and at that point the dosage is not increased further. It is contemplated that the various pharmaceutical compositions used to practice the method of the present invention should contain about 0.01 ng to about 100 mg (preferably about 0.1 ng to about 10 mg, more preferably about 0.1 microgram to about 1 mg) of polypeptide of the present invention per kg body weight. In one embodiment of the invention, HPR1 and/or HPR2 polypeptides or antagonists are administered one time per week to treat the various medical disorders disclosed herein, in another embodiment is administered at least two times per week, and in another embodiment is administered at least three times per week. If injected, the effective amount of HPR1 or HPR2 polypeptides or antagonists per adult dose ranges from 1-20 mg/m<sup>2</sup>, and preferably is about 5-12 mg/m<sup>2</sup>. Alternatively, a flat dose can be administered, whose amount may range from 5-100 mg/dose. Exemplary dose ranges for a flat dose to be administered by subcutaneous injection are 5-25 mg/dose, 25-50 mg/dose and 50-100 mg/dose. In one embodiment of the invention, the various indications described below are treated by administering a preparation acceptable for injection containing HPR1 and/or HPR2 polypeptides or antagonists at 25 mg/dose, or alternatively, containing 50 mg per dose. The 25 mg or 50 mg dose can be administered repeatedly, particularly for chronic conditions. If a route of administration other than injection is used, the dose is appropriately adjusted in accord with standard medical practices. In many instances, an improvement in a patient's condition will be obtained by injecting a dose of about 25 mg of HPR1 or HPR2 polypeptides or antagonists one to three times per week over a period of at least three weeks, or a dose of 50 mg of HPR1 or HPR2 polypeptides or antagonists one or two times per week for at least three weeks, though treatment for longer periods may be necessary to induce the desired degree of improvement. For incurable chronic conditions, the regimen can be continued indefinitely, with adjustments being made to dose and frequency if such are deemed necessary by the patient's physician. The foregoing doses are examples for an adult patient who is a person who is 18 years of age or older. For pediatric patients (age 4-17), a suitable regimen involves the subcutaneous injection of 0.4 mg/kg, up to a maximum dose of 25 mg of HPR1 or HPR2 polypeptides or antagonists, administered by subcutaneous injection one or more times per week. If an antibody against an HPR1 and/or HPR2 polypeptide is used as the HPR1



- 5 and/or HPR2 polypeptide antagonist, a preferred dose range is 0.1 to 20 mg/kg, and more preferably is 1-10 mg/kg. Another preferred dose range for an anti-HPR1 polypeptide and/or anti-HPR2 polypeptide antibody is 0.75 to 7.5 mg/kg of body weight. Humanized antibodies are preferred, that is, antibodies in which only the antigen-binding portion of the antibody molecule is derived from a non-human source. Such antibodies can be injected or administered intravenously.
- 10 Formulations. Compositions comprising an effective amount of an HPR1 and/or HPR2 polypeptide of the present invention (from whatever source derived, including without limitation from recombinant and non-recombinant sources), in combination with other components such as a physiologically acceptable diluent, carrier, or excipient, are provided herein. The term "pharmaceutically acceptable" means a non-toxic material that does not interfere with the effectiveness
- 15 of the biological activity of the active ingredient(s). Formulations suitable for administration include aqueous and non-aqueous sterile injection solutions which can contain anti-oxidants, buffers, bacteriostats and solutes which render the formulation isotonic with the blood of the recipient; and aqueous and non-aqueous sterile suspensions which can include suspending agents or thickening agents. The polypeptides can be formulated according to known methods used to prepare
- 20 pharmaceutically useful compositions. They can be combined in admixture, either as the sole active material or with other known active materials suitable for a given indication, with pharmaceutically acceptable diluents, preservatives, emulsifiers, solubilizers, adjuvants and/or carriers. Suitable formulations for pharmaceutical compositions include those described in *Remington's Pharmaceutical Sciences*, 16th ed. 1980, Mack Publishing Company, Easton, PA. In addition, such compositions can
- 25 be complexed with polyethylene glycol (PEG), metal ions, or incorporated into polymeric compounds such as polyacetic acid, polyglycolic acid, hydrogels, dextran, etc., or incorporated into liposomes, microemulsions, micelles, unilamellar or multilamellar vesicles, erythrocyte ghosts or spheroblasts. Suitable lipids for liposomal formulation include, without limitation, monoglycerides, diglycerides, sulfatides, lysolecithin, phospholipids, saponin, bile acids, and the like. Preparation of such liposomal
- 30 formulations is within the level of skill in the art, as disclosed, for example, in U.S. Pat. No. 4,235,871; U.S. Pat. No. 4,501,728; U.S. Pat. No. 4,837,028; and U.S. Pat. No. 4,737,323. Such compositions will influence the physical state, solubility, stability, rate of *in vivo* release, and rate of *in vivo* clearance, and are thus chosen according to the intended application, so that the characteristics of the carrier will depend on the selected route of administration. In one preferred embodiment of the invention,
- 35 sustained-release forms of HPR1 and/or HPR2 polypeptides are used. Sustained-release forms suitable for use in the disclosed methods include, but are not limited to, HPR1 and/or HPR2 polypeptides that are encapsulated in a slowly-dissolving biocompatible polymer (such as the alginate microparticles described in U.S. No. 6,036,978), admixed with such a polymer (including topically applied hydrogels), and or encased in a biocompatible semi-permeable implant.
- 40 Combinations of Therapeutic Compounds. An HPR1 or HPR2 polypeptide of the present invention may be active in multimers (e.g., heterodimers or homodimers) or complexes with itself or other polypeptides. As a result, pharmaceutical compositions of the invention may comprise a

5 polypeptide of the invention in such multimeric or complexed form. The pharmaceutical composition of the invention may be in the form of a complex of the polypeptide(s) of present invention along with polypeptide or peptide antigens. The invention further includes the administration of HPR1 and/or HPR2 polypeptides or antagonists concurrently with one or more other drugs that are administered to the same patient in combination with the HPR1 and/or HPR2 polypeptides or antagonists, each drug  
10 being administered according to a regimen suitable for that medicament. "Concurrent administration" encompasses simultaneous or sequential treatment with the components of the combination, as well as regimens in which the drugs are alternated, or wherein one component is administered long-term and the other(s) are administered intermittently. Components can be administered in the same or in separate compositions, and by the same or different routes of administration. Examples of components  
15 that can be included in the pharmaceutical composition of the invention are: cytokines, lymphokines, or other hematopoietic factors such as M-CSF, GM-CSF, TNF, IL-1, IL-2, IL-3, IL-4, IL-5, IL-6, IL-7, IL-8, IL-9, IL-10, IL-11, IL-12, IL-13, IL-14, IL-15, IL-17, IL-18, IL-23, IFN, TNF $\alpha$ , TNF $\beta$ , TNF $\gamma$ , G-CSF, Meg-CSF, thrombopoietin, stem cell factor, and erythropoietin. The pharmaceutical composition can further contain other agents which either enhance the activity of the polypeptide or complement its  
20 activity or use in treatment. Such additional factors and/or agents may be included in the pharmaceutical composition to produce a synergistic effect with polypeptide of the invention, or to minimize side effects. Additional examples of drugs to be administered concurrently include but are not limited to antivirals, antibiotics, analgesics, corticosteroids, antagonists of inflammatory cytokines, non-steroidal anti-inflammatories, pentoxifylline, thalidomide, and disease-modifying antirheumatic  
25 drugs (DMARDs) such as azathioprine, cyclophosphamide, cyclosporine, hydroxychloroquine sulfate, methotrexate, leflunomide, minocycline, penicillamine, sulfasalazine and gold compounds such as oral gold, gold sodium thiomalate, and aurothioglucose. Additionally, HPR1 and/or HPR2 polypeptides or antagonists can be combined with a second HPR1 and/or HPR2 polypeptide/antagonist, including an antibody against an HPR1 and/or HPR2 polypeptide, or an HPR1 polypeptide-derived peptide or HPR2  
30 polypeptide-derived peptide that acts as a competitive inhibitor of native HPR1 and/or HPR2 polypeptides.

Routes of Administration. Any efficacious route of administration may be used to therapeutically administer HPR1 and HPR2 polypeptides or antagonists thereof, including those compositions comprising nucleic acids. Parenteral administration includes injection, for example, via  
35 intra-articular, intravenous, intramuscular, intralesional, intraperitoneal or subcutaneous routes by bolus injection or by continuous infusion, and also includes localized administration, e.g., at a site of disease or injury. Other suitable means of administration include sustained release from implants; aerosol inhalation and/or insufflation; eyedrops; vaginal or rectal suppositories; buccal preparations; oral preparations, including pills, syrups, lozenges or chewing gum; and topical preparations such as  
40 lotions, gels, sprays, ointments or other suitable techniques. Alternatively, polypeptideaceous HPR1 and HPR2 polypeptides or antagonists may be administered by implanting cultured cells that express the polypeptide, for example, by implanting cells that express HPR1 and/or HPR2 polypeptides or

5 antagonists. Cells may also be cultured *ex vivo* in the presence of polypeptides of the present invention in order to proliferate or to produce a desired effect on or activity in such cells. Treated cells can then be introduced *in vivo* for therapeutic purposes. In another embodiment, the patient's own cells are induced to produce HPR1 and/or HPR2 polypeptides or antagonists by transfection *in vivo* or *ex vivo* with a DNA that encodes HPR1 and/or HPR2 polypeptides or antagonists. This DNA can be  
10 introduced into the patient's cells, for example, by injecting naked DNA or liposome-encapsulated DNA that encodes HPR1 and/or HPR2 polypeptides or antagonists, or by other means of transfection. Nucleic acids of the invention can also be administered to patients by other known methods for introduction of nucleic acid into a cell or organism (including, without limitation, in the form of viral vectors or naked DNA). When HPR1 and/or HPR2 polypeptides or antagonists are administered in  
15 combination with one or more other biologically active compounds, these can be administered by the same or by different routes, and can be administered simultaneously, separately or sequentially.

Oral Administration. When a therapeutically effective amount of polypeptide of the present invention is administered orally, polypeptide of the present invention will be in the form of a tablet, capsule, powder, solution or elixir. When administered in tablet form, the pharmaceutical composition  
20 of the invention can additionally contain a solid carrier such as a gelatin or an adjuvant. The tablet, capsule, and powder contain from about 5 to 95% polypeptide of the present invention, and preferably from about 25 to 90% polypeptide of the present invention. When administered in liquid form, a liquid carrier such as water, petroleum, oils of animal or plant origin such as peanut oil, mineral oil, soybean oil, or sesame oil, or synthetic oils can be added. The liquid form of the pharmaceutical composition  
25 can further contain physiological saline solution, dextrose or other saccharide solution, or glycols such as ethylene glycol, propylene glycol or polyethylene glycol. When administered in liquid form, the pharmaceutical composition contains from about 0.5 to 90% by weight of polypeptide of the present invention, and preferably from about 1 to 50% polypeptide of the present invention.

Intravenous Administration. When a therapeutically effective amount of polypeptide of the present invention is administered by intravenous, cutaneous or subcutaneous injection, polypeptide of  
30 the present invention will be in the form of a pyrogen-free, parenterally acceptable aqueous solution. The preparation of such parenterally acceptable polypeptide solutions, having due regard to pH, isotonicity, stability, and the like, is within the skill in the art. A preferred pharmaceutical composition for intravenous, cutaneous, or subcutaneous injection should contain, in addition to polypeptide of the present invention, an isotonic vehicle such as Sodium Chloride Injection, Ringer's Injection, Dextrose  
35 Injection, Dextrose and Sodium Chloride Injection, Lactated Ringer's Injection, or other vehicle as known in the art. The pharmaceutical composition of the present invention can also contain stabilizers, preservatives, buffers, antioxidants, or other additives known to those of skill in the art. The duration of intravenous therapy using the pharmaceutical composition of the present invention will vary,  
40 depending on the severity of the disease being treated and the condition and potential idiosyncratic response of each individual patient. It is contemplated that the duration of each application of the polypeptide of the present invention will be in the range of 12 to 24 hours of continuous intravenous

5 administration. Ultimately the attending physician will decide on the appropriate duration of intravenous therapy using the pharmaceutical composition of the present invention.

Bone and Tissue Administration. For compositions of the present invention which are useful for bone, cartilage, tendon or ligament disorders, the therapeutic method includes administering the composition topically, systematically, or locally as an implant or device. When administered, the therapeutic composition for use in this invention is, of course, in a pyrogen-free, physiologically acceptable form. Further, the composition can desirably be encapsulated or injected in a viscous form for delivery to the site of bone, cartilage or tissue damage. Topical administration may be suitable for wound healing and tissue repair. Therapeutically useful agents other than a polypeptide of the invention which can also optionally be included in the composition as described above, can alternatively or additionally, be administered simultaneously or sequentially with the composition in the methods of the invention. Preferably for bone and/or cartilage formation, the composition would include a matrix capable of delivering the polypeptide-containing composition to the site of bone and/or cartilage damage, providing a structure for the developing bone and cartilage and optimally capable of being resorbed into the body. Such matrices can be formed of materials presently in use for other implanted medical applications. The choice of matrix material is based on biocompatibility, biodegradability, mechanical properties, cosmetic appearance and interface properties. The particular application of the compositions will define the appropriate formulation. Potential matrices for the compositions can be biodegradable and chemically defined calcium sulfate, tricalciumphosphate, hydroxyapatite, polylactic acid, polyglycolic acid and polyanhydrides. Other potential materials are biodegradable and biologically well-defined, such as bone or dermal collagen. Further matrices are comprised of pure polypeptides or extracellular matrix components. Other potential matrices are nonbiodegradable and chemically defined, such as sintered hydroxapatite, bioglass, aluminates, or other ceramics. Matrices can be comprised of combinations of any of the above mentioned types of material, such as polylactic acid and hydroxyapatite or collagen and tricalciumphosphate. Presently preferred is a 50:50 (mole weight) copolymer of lactic acid and glycolic acid in the form of porous particles having diameters ranging from 150 to 800 microns. In some applications, it will be useful to utilize a sequestering agent, such as carboxymethyl cellulose or autologous blood clot, to prevent the polypeptide compositions from disassociating from the matrix. A preferred family of sequestering agents is cellulosic materials such as alkylcelluloses, the most preferred being cationic salts of carboxymethylcellulose (CMC). Other preferred sequestering agents include hyaluronic acid, sodium alginate, poly(ethylene glycol), polyoxyethylene oxide, carboxyvinyl polymer and poly(vinyl alcohol). The amount of sequestering agent useful herein is 0.5-20 wt %, preferably 1-10 wt % based on total formulation weight, which represents the amount necessary to prevent desorption of the polypeptide from the polymer matrix and to provide appropriate handling of the composition, yet not so much that the progenitor cells are prevented from infiltrating the matrix, thereby providing the polypeptide the opportunity to assist the osteogenic activity of the progenitor cells. In further compositions, polypeptides of the invention can be combined with other agents beneficial to the treatment of the bone

5 and/or cartilage defect, wound, or tissue in question. Progress can be monitored by periodic assessment of tissue/bone growth and/or repair, for example, X-rays, histomorphometric determinations and tetracycline labeling.

Veterinary Uses. In addition to human patients, HPR1 and HPR2 polypeptides and antagonists are useful in the treatment of disease conditions in non-human animals, such as pets (dogs, cats, birds, primates, etc.), domestic farm animals (horses cattle, sheep, pigs, birds, etc.), or any animal  
10 that suffers from a TNF $\alpha$ -mediated inflammatory or arthritic condition. In such instances, an appropriate dose can be determined according to the animal's body weight. For example, a dose of 0.2-1 mg/kg may be used. Alternatively, the dose is determined according to the animal's surface area, an exemplary dose ranging from 0.1-20 mg/m<sup>2</sup>, or more preferably, from 5-12 mg/m<sup>2</sup>. For small  
15 animals, such as dogs or cats, a suitable dose is 0.4 mg/kg. In a preferred embodiment, HPR1 and/or HPR2 polypeptides or antagonists (preferably constructed from genes derived from the same species as the patient), are administered by injection or other suitable route one or more times per week until the animal's condition is improved, or they can be administered indefinitely.

Manufacture of Medicaments. The present invention also relates to the use of HPR1 and  
20 HPR2 polypeptides, fragments, and variants; nucleic acids encoding the HPR1 or HPR2 polypeptides, fragments, and variants; agonists or antagonists of the HPR1 and/or HPR2 polypeptides such as antibodies; HPR1 and/or HPR2 polypeptide binding partners; complexes formed from the HPR1 and/or HPR2 polypeptides, fragments, variants, and binding partners, etc, in the manufacture of a medicament for the prevention or therapeutic treatment of each medical disorder disclosed herein.

## 25 EXAMPLES

The following examples are intended to illustrate particular embodiments and not to limit the scope of the invention.

### EXAMPLE 1

**A. Identification of HPR1, a New Member of the Human Hematopoietin Receptor Family**  
30 A data set was received from Celera Genomics (Rockville, Maryland) containing a listing of amino acid sequences predicted to be encoded by the human genome. This data set was searched with a BLAST algorithm to identify hematopoietin receptor family polypeptides. Several amino acid sequences, including two overlapping amino acid sequences (SEQ ID NO: 1 and SEQ ID NO:2), were identified as comprising partial amino acid sequences of a new human hematopoietin receptor  
35 polypeptide, HPR1. These amino acids sequences were used to identify a DNA sequence (SEQ ID NO:3) encoding an HPR1 polypeptide having the amino acid sequence shown in SEQ ID NO:4; nucleotides 132 through 2366 of SEQ ID NO:3 encode SEQ ID NO:4, with nucleotides 2367 through 2369 corresponding to a stop codon. The HPR1 coding sequence (nucleotides 132 through 2369 of SEQ ID NO:3) is presented as SEQ ID NO:5. The HPR1 sequences of SEQ ID NOs 3 and 5 were  
40 confirmed by three independent PCR amplification experiments from a U937 cDNA library. These HPR1 coding sequences were compared with publicly available preliminary human genomic DNA sequences, and the following chromosome 5 contigs were identified as containing HPR1 coding sequences: AC022265.3, AC008914.3, AC008857.4, and AC016596.4. The human genomic region

- 5 corresponding to these contigs also includes the gene for gp130, which suggests that gp130 and HPR1 may derive from a common ancestral gene by gene duplication. The approximate positions of the exons containing HPR1 coding sequence in the AC022265.3 contig are shown in the table below, along with their locations relative to SEQ ID NOs 3 and 5; note that the 5' and 3' untranslated regions may extend further along the contig sequence beyond those portions that correspond to SEQ ID NOs 3 and 10 5, as indicated by the parentheses around the AC022265.3 endpoints in the table. Due to the preliminary sequence and assembly of the contig sequence, the exons within the contig are not always in the right order or orientation with respect to each other, and may contain sequence variations due to inaccurate sequence data or allelic polymorphism.

Corresponding positions of HPR1 gene exons in human contig AC022265.3 and in cDNA sequences:

	Position in AC022265.3	Position in SEQ ID NO:3 / Position in SEQ ID NO:5
Exon 1	(128423)-128559	1-137 / 1-6
Exon 2	134501-134591	138-228 / 7-97
Exon 3	143777-143894	229-346 / 98-215
Exon 4	147256-147437	347-528 / 216-397
Exon 5	51249-51098	529-680 / 398-549
Exon 6	44322-44157	681-846 / 550-715
Exon 7	16473-16394	847-926 / 716-795
Exon 8	30331-30115	927-1143 / 796-1012
Exon 9	178626-178808	1144-1326 / 1013-1195
Exon 10	179879-179980	1327-1428 / 1196-1297
Exon 11	180785-180931	1429-1575 / 1298-1444
Exon 12	183052-183192	1576-1716 / 1445-1585
Exon 13	185997-186090	1717-1810 / 1586-1679
Exon 14	187367-187448	1811-1892 / 1680-1761
Exon 15	189165-(189747)	1893-2480 / 1762-2238

- 15 A nucleic acid encoding a polypeptide with a high degree of amino acid similarity (approximately 61% amino acid identity) to human HPR1 was isolated from *Mus musculus*. The *Mus* HPR1 amino acid sequence is presented as SEQ ID NO:12, and due to its high level of similarity with human HPR1, is considered to be the murine homologue of human HPR1. PCR amplification of cDNA sequences corresponding to mRNAs encoding murine HPR1 identified a cDNA molecule 20 encoding SEQ ID NO:12; the nucleotide sequence of this murine HPR1 cDNA is presented as SEQ ID NO:28. Nucleotides 1 through 2178 of SEQ ID NO:28 encode SEQ ID NO:12, with nucleotides 2179

- 5 acids 56 through 77 of SEQ ID NO:1 may be a portion of an alternatively spliced exon added following the exon/intron boundary identified between nucleotides 846 and 847 of SEQ ID NO:3 (nucleotides 715 and 716 of SEQ ID NO:5). In an additional potential splice variant, an amino acid sequence ending in the amino acids of SEQ ID NO:10 could be substituted for the amino acids leading up to and including the lysine at position 190 of SEQ ID NO:4. However, such a splice variant would require an additional exon/intron boundary approximately between nucleotides 701 and 702 of SEQ ID NO:3 (nucleotides 570 and 571 of SEQ ID NO:5). In a further potential splice variant, the amino acid sequence of SEQ ID NO:11 could be substituted for amino acids 238 through 266 of SEQ ID NO:4 by replacing exon 7 with an alternative exon encoding the SEQ ID NO:11 amino acids. In this potential variant, 29 amino acids C-terminal to the WSXWS motif and including the N-terminal portion of the most N-terminal fibronectin type III repeat (as shown in Table 1) would be replaced with 15 amino acids, resulting in deletion of a portion of the most N-terminal fibronectin type III repeat, including two highly conserved Trp residues.

- Additional variations of HPR1 polypeptides are provided as naturally occurring genomic variants of the HPR1 sequences disclosed herein; such variations may be incorporated into an HPR1 polypeptide or nucleic acid individually or in any combination, or in combination with alternative splice variation as described above. As one example, amino acids 5 through 40 of SEQ ID NO:2 match SEQ ID NO:4, with amino acid 4 of SEQ ID NO:2 likely representing an allelic variation, where the change from the Asn residue position 187 of SEQ ID NO:4 to a Thr residue in SEQ ID NO:2 could be caused by a single change from 'A' to 'C' at position 691 of SEQ ID NO:3 or 560 of SEQ ID NO:5. This variation and others are listed in the table below:

Amino Acid Change	Position in SEQ ID NO:4	Nucleotide Change	Position in SEQ ID NO:3 / Position in SEQ ID NO:5
Thr -> Ala	83	A -> G	378 / 247
Asp -> Asn	168	G -> A	633 / 502
Asn -> Thr	187	A -> C	691 / 560
Ser -> Pro	361	T -> C	1212 / 1081
Ala -> Gly	362	C -> G	1216 / 1085
Ser -> Asn	510	G -> A	1660 / 1529
Asn -> Asp	517	A -> G	1680 / 1549
Arg -> Gly	679	A -> G	2166 / 2035

#### B. Identification of HPR2, a New Member of the Human Hematopoietin Receptor Family

- A data set was received from Celera Genomics (Rockville, Maryland) containing a listing of amino acid sequences predicted to be encoded by the human genome. This data set was searched with a BLAST algorithm to identify hematopoietin receptor family polypeptides. Several amino acid sequences, including SEQ ID NO:16, were identified as comprising partial amino acid sequences of a new human hematopoietin receptor polypeptide, HPR2. These amino acids sequences were used to identify a DNA sequence (SEQ ID NO:19) encoding an HPR2 polypeptide having the amino acid sequence shown in SEQ ID NO:21; nucleotides 107 through 1993 of SEQ ID 19 encode SEQ ID

5 NO:21, with nucleotides 1994 through 1996 corresponding to a stop codon. The HPR2 coding sequence (nucleotides 107 through 1996 of SEQ ID NO:19) is presented as SEQ ID NO:20. The HPR2 sequences of SEQ ID NOs 19 and 20 were confirmed by independent PCR amplification experiments from a human lymph node cDNA library and a CB23 B cell line cDNA library. These PCR  
10 amplification experiments also identified two additional splice variants of the HPR2 cDNA sequence referred to as HPR2-ex8-ex9 and HPR2-ex9; the coding sequences for HPR2-ex8-ex9 and HPR2-ex9 are presented as SEQ ID NOs 22 and 24, respectively, and the amino acid sequences they encode are presented as SEQ ID NOs 23 and 25, respectively. The HPR2 cDNA sequences of SEQ ID NOs 19, 20, and the HPR2-ex8-ex9 cDNA of SEQ ID NO:22 were present in both the lymph node and CB23  
15 cDNA libraries, while the HPR2-ex9 cDNA of SEQ ID NO:24 was only present in the lymph node library.

These HPR2 coding sequences were compared with publicly available preliminary human genomic DNA sequences, and the following chromosome 1 contigs were identified as containing HPR2 coding sequences: GenBank accession numbers AL109843 (1p31.2-32.1) and AL389925. The human genomic region corresponding to the AL389925 contig also includes the gene for IL-12RB2,  
20 which suggests that IL-12RB2 and HPR2 may derive from a common ancestral gene by gene duplication. The approximate positions of the exons containing HPR2 coding sequence in the AL109843 and AL389925 contigs are shown in the table below, along with their locations relative to SEQ ID NOs 19, 20, 22, and 24; note that the 5' and 3' untranslated regions may extend further along the contig sequence beyond those portions that correspond to SEQ ID NOs 19, 20, 22, and 24, as  
25 indicated by the parentheses around the AL109843 and AL389925 endpoints in the table. Due to the preliminary nature of the sequence data and assembly of the contig sequence, the exons within the genomic contigs may contain sequence variations due to inaccurate sequence data or allelic polymorphism.

Corresponding positions of HPR2 gene exons in human genomic contigs AL109843 and AL389925  
30 and in HPR2 coding sequences:

	Position in AL109843	Position in SEQ ID NO:19 / 20 / 22 / 24
Exon 1	(34088)-34164	1-77 / (5' UTR, not in SEQ ID NOs 20, 22, and 24)
Exon 2	35715-35813	78-176 / 1-70 / 1-70 / 1-70
Exon 3	36965-37261	177-473 / 71-367 / 71-367 / 71-367
Exon 4	50459-50582	474-597 / 368-491 / 368-491 / 368-491
Exon 5	68360-68520	598-758 / 492-652 / 492-652 / 492-652
Exon 6	74533-74678	759-904 / 653-798 / 653-798 / 653-798
Exon 7	87197-87353	905-1061 / 799-955 / 799-955 / 799-955
Exon 8	104336-104425	1062-1151 / 956-1045 / (not present) / 956-1045
Exon 9	107802-107904	1152-1254 / 1046-1148 / (not present) / (not present)
	Position in AL389925	Position in SEQ ID NO:19 / 20 / 22 / 24
Exon 10	8847-8937	1255-1345 / 1149-1239 / 'G'-957-1047 / 1046-1071
Exon 11	11488-(12972)	1346-2830 / 1240-1890 / 1048-1698 / (not present)

In the HPR3-ex9 splice variant, note that the absence of the exon 9 sequence (103 nucleotides) changes the reading frame towards the 3' end of the coding sequence for the HPR2-ex9 form (SEQ ID NO:24)



5 relative to that of the HPR2 coding sequence of SEQ ID NO:20, leading to a different amino acid sequence in the HPR2-ex9 C-terminal portion and a stop codon after amino acid 356 (compared to 629 amino acids in HPR2). For the HPR2-ex8-ex9 form, the splice is made at a slightly different exon 10 splice acceptor site than for the HPR2 form, so that an extra 'G' residue is included at the start of exon 10 in the HPR2-ex8-ex9 form, restoring the reading frame to be the same as in the 3' end of the HPR2 sequence. The C-terminal 248 amino acids of HPR2-ex8-ex9 form are therefore the same as the C-terminal 248 amino acids of HPR2 form, and although the coding sequence of the HPR2-ex8-ex9 form is missing both exons 8 and 9 (except for the last 'G' residue of exon 9), the resulting HPR2-ex8-ex9 form polypeptide is longer (565 amino acids) than the HPR2-ex9 form polypeptide (356 amino acids).

10 Several splice variations of the HPR2 sequences have been identified in human genomic sequences and are included within the scope of the invention. For example, amino acids 118 through 215 of SEQ ID NO:16 match the amino acid sequence of HPR2 presented in SEQ ID NO:21, while amino acids 1 through 117 of SEQ ID NO:16 may correspond to an alternatively spliced exon added upstream of exon 3 (i.e. at the exon/intron boundary identified between nucleotides 176 and 177 of SEQ ID NO:19). Amino acids 216 through 245 of SEQ ID NO:16 may correspond to an additional alternatively spliced exon added between exon 3 and exon 4 (i.e. at the exon/intron boundary identified between nucleotides 473 and 474 of SEQ ID NO:19). Amino acids 340 through 344 of SEQ ID NO:16 may correspond to an alternatively spliced exon added downstream of exon 5 (i.e. at the exon/intron boundary identified between nucleotides 758 and 759 of SEQ ID NO:19). In a further potential splice variant, an alternative exon or exons encoding the amino acid sequence of SEQ ID NO:17 could be substituted for exon 6, resulting in the replacement of amino acids 217 through 267 of SEQ ID NO:21 with the SEQ ID NO:17 amino acids. In this potential variant, 51 amino acids N-terminal to the WSXWS motif, including the proline-rich region (as shown in Table 1) between the two cytokine receptor subdomains, would be replaced with 39 amino acids, resulting in deletion of a portion of the more C-terminal cytokine receptor subdomain which includes a highly conserved Trp residue. In an additional potential splice variant, an alternative exon could be added downstream of exon 4 (i.e. at the exon/intron boundary identified between nucleotides 597 and 598 of SEQ ID NO:19) so that an amino acid sequence starting in the amino acids of SEQ ID NO:18 could be substituted for amino acids following and including the serine at position 164 of SEQ ID NO:21. Multiple splice variations as described above can be included in a single splice variant, for example, replacing exon 6 with an alternative exon or exons encoding the amino acid sequence of SEQ ID NO:17, and also deleting exons 8 and/or 9 as described above.

35 Additional variations of HPR2 polypeptides are provided as naturally occurring genomic variants of the HPR2 sequences disclosed herein; such variations may be incorporated into an HPR2 polypeptide or nucleic acid individually or in any combination, or in combination with alternative splice variation as described above. As one example, a change from the Leu residue position 310 of SEQ ID NO:21 to a Pro residue could be caused by a single change from 'T' to 'C' at position 1035 of SEQ ID NO:19. This variation and another are listed in the table below:

Amino Acid Change	Position in SEQ ID NO:21	Nucleotide Change	Position in SEQ ID NO:19
Leu->Pro	310	T->C	1035
(not applicable)	(not applicable)	A->G	2172 (3' UTR)

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A nucleic acid encoding a polypeptide with a high degree of amino acid similarity (approximately 69% amino acid identity) to human HPR2 was isolated from *Mus musculus*. The *Mus* HPR2 amino acid sequence is presented as SEQ ID NO:27, and due to its high level of similarity with human HPR2, is considered to be the murine homologue of human HPR2. PCR amplification of cDNA sequences corresponding to mRNAs encoding murine HPR2 identified a cDNA molecule encoding SEQ ID NO:27; the nucleotide sequence of this murine HPR2 cDNA is presented as SEQ ID NO:29. Nucleotides 1 through 1932 of SEQ ID NO:29 encode SEQ ID NO:27, with nucleotides 1933-1935 corresponding to a stop codon. The murine HPR2 amino acid sequence of SEQ ID NO:27 appears to have a 20-amino acid insertion at amino acids 297 through 316 of SEQ ID NO:27 relative to human HPR2 of SEQ ID NO:21, based on an alignment of the human and murine polypeptide sequences; this insertion is identical to amino acids 317 through 336. Given the number of alternatively spliced forms identified for human HPR2, it is possible that this insertion in murine HPR2 relative to the human HPR2 of SEQ ID NO:21 is the result of alternative splicing. One embodiment of the invention is a form of murine HPR2 in which one of these repeated WQPWS-containing motifs has been deleted; that is, polypeptides in which the amino acid sequence ending with amino acid 296 of SEQ ID NO:27 is contiguous with the amino acid sequence beginning with amino acid 317 of SEQ ID NO:27, or polypeptides in which the amino acid sequence ending with amino acid 316 of SEQ ID NO:27 is contiguous with the amino acid sequence beginning with amino acid 337 of SEQ ID NO:27.

#### 25 C. Comparison of HPR1 and HPR2 to Other Hematopoietin Receptor Polypeptides.

The amino acid sequences of human HPR1 (SEQ ID NO:4), murine HPR1 (SEQ ID NO:12), and human HPR2 (SEQ ID NO:21) were compared with the amino acid sequences of these other hematopoietin receptor family members - LIF-R, the interleukin 12 beta 2 receptor chain (IL-12RB2), gp130, and GCSFR (SEQ ID NO:6 - SEQ ID NO:9, respectively) - using the GCG "pretty" multiple sequence alignment program, with amino acid similarity scoring matrix = blosum62, gap creation penalty = 8, and gap extension penalty = 2. Alignments of these sequences are shown in Table 1, and include consensus residues which are identical among at least three of the amino acid sequences in the alignment. The capitalized residues in the alignment are those which match the consensus residues. The numbering of amino acid residues in Table 1 corresponds to the position of those residues in the HPR1 amino acid sequence (SEQ ID NO:4). Note that only a portion of the HPR2 amino acid sequence is shown in Table 1, as HPR2 does not contain fibronectin type III repeats in its extracellular domain. HPR1 and HPR2 sequences corresponding to the intracellular Box 1 and Box 2 motifs are shown in Table 2. Sequences of eleven amino acids similar to the Box 1 or 2 motif of other hematopoietin receptors were identified for HPR1 and HPR2, and placed into a column with these motif sequences (with no gaps introduced). Similarly, HPR2 sequences corresponding to the

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5 intracellular Box 3 motif are shown in Table 3. Sequences of fourteen amino acids similar to the Box 3 motif of other hematopoietin receptors were identified for HPR2, and placed into a column with these motif sequences (with no gaps introduced). The numbering of each sequence on Tables 2 and 3 corresponds to their position in the complete amino acid sequence for that HPR polypeptide. The consensus residues are those that are present in three or more (for Table 2) or two or more (for Table 3) sequences at that position in the motif.

Amino acid substitutions and other alterations (deletions, insertions, etc.) to HPR1 and HPR2 amino acid sequences (for example, SEQ ID NOs 4, 12, and 21) are predicted to be more likely to alter or disrupt HPR1 or HPR2 polypeptide activities if they result in changes to the capitalized residues of the amino acid sequences as shown in Tables 1, 2, and 3, and particularly if those changes do not substitute an amino acid of similar structure (such as substitution of any one of the aliphatic residues - Ala, Gly, Leu, Ile, or Val - for another aliphatic residue), or a residue present in other hematopoietin receptor polypeptides at that conserved position. Conversely, if a change is made to an HPR1 or HPR2 amino acid sequence resulting in substitution of the residue at that position in the alignment from one of the other Table 1, 2, or 3 hematopoietin receptor polypeptide sequences, it is less likely that such an alteration will affect the function of the altered HPR1 or HPR2 polypeptide. For example, the consensus residue at position 42 in Table 1 is serine, and one of the hematopoietin receptors (LIF-R) has an asparagine at that position. Substitution of asparagine or the chemically similar glutamine for serine at that position is considered to be less likely to alter the function of the polypeptide than substitution of tryptophan or tyrosine etc. Embodiments of the invention include HPR1 and HPR2 polypeptides and fragments of HPR1 and HPR2 polypeptides, comprising altered amino acid sequences. Altered HPR1 or HPR2 polypeptide sequences share at least 30%, or more preferably at least 40%, or more preferably at least 50%, or more preferably at least 55%, or more preferably at least 60%, or more preferably at least 65%, or more preferably at least 70%, or more preferably at least 75%, or more preferably at least 80%, or more preferably at least 85%, or more preferably at least 90%, or more preferably at least 95%, or more preferably at least 97.5%, or more preferably at least 99%, or most preferably at least 99.5% amino acid identity with one or more of the hematopoietin receptor amino acid sequences shown in Tables 1, 2, and 3.

**Table 1: Alignment of HPR1 and HPR2 extracellular domains with those of other hematopoietin receptors**

35 C : conserved cysteine  
 ■■■■■ : proline-rich 'linker' between cytokine receptor subdomains  
 ■■■■■ : WSXWS motif  
 ■■■■■ : fibronectin type III repeats  
 ■■■■■ : transmembrane domain

	SEQ ID NO:		78
Hs HPR1	4	PaKPeNiSCV yYyr.KNLTC TWsPGkETs. ....yTqYTv KrtYafGekh	
Mus HPR1	12	PtKPeNiSCV fYfd.rNLTC TWrPekETn. ....dTSYiv tltySyGK..	
gp130	8	PeKPkNLSCi vneg.KkmrC eWdgGrETHL ....eTnfTL KsewathKfa	
GCSFR	9	PaiPhNLSCl mnlttssLiC qWePGpETHL ....pTSfTL KsfkSrGnCc	
Hs HPR2	21	PdiPdevtCV iYeysgNmTC TWnaGklTyi ....dTkYvv hv.....Ksl	

IL-12RB2	7	PegPqNLSCi qkgegggtvaC TWerGrdTHL ...yTeYTL ql..SgpKnl	
LIF-R	6	PdtPqgLnCe th.dlKeiiC sWnPGrvTaL vgpratSYTL vesfS.GKyv	
consensus		P-KP-NLSCV -Y---KNLTC TW-PG-ETHL -----TSYTL K---S-GK--	
		79	126
Hs HPR1	4	dnCttnsststs enrasCsffl PRiti..pdN YtieVeAENg dGvikShmty	
Mus HPR1	12	.....snys dnateasysf PRscamppdi csVeVQAoNg dGkvkSdity	
gp130	8	dCkagr.... dtptsCtvdY stvyfv...N ieVWVeAENA LGkvtSdhin	
GCSFR	9	tqgdsildcv pkdggshCci PRkhlllycN mgiWVQAENA LGtSmSpqLc	
Hs HPR2	21	eteeeggylt ssY....ini stdslgggkk YlVWVQAaNA LGmeeSkqLq	
IL-12RB2	7	twqkqCkdiy CdYldfginL tpespe..sN ftakVtAvNs LGsSSslpst	
LIF-R	6	rlkraeaptn esYqlifqML Pngei..... YnftlnAhNp LGrSqStiL.	
consensus		----- --Y-----L PR-----N Y-VWVQAENA LG-S-S--L-	
		127	172
Hs HPR1	4	wrLenIaKtE PPkIfRVKpV lgi....krm iQieWikPel apvssdLKyt	
Mus HPR1	12	whLisIaKtE PPIIlsVnPI ..c....nrm fQiqW.kPre ktrgfpLvCm	
gp130	8	fdpvykVKPn PPhnlSvins eel....ssi lKlTWtnPsi ksv.IiLKyn	
GCSFR	9	ldpmDvVKLE PPmlrtmdPs peaappgagc lQLcW.ePwg pglhInqKCE	
Hs HPR2	21	ihLdDIViPs aavIsRaetI natvpkti... ..iyWds... qttiekvsCE	
IL-12RB2	7	ftfLDIVrPl PPwdiRiKfq kasvsrct... ..LyWrd... eglv..Llnr	
LIF-R	6	vnitekVyPh tPtsfKVKdI nsta..... vkLsWhlPg. nfakInflCE	
consensus		--L-DIVKPE PP-I-RVKPI ----- -QL-W--P-- ----I-LKCE	
		173	221
Hs HPR1	4	LrFRTvNS.t sWmeVnFakN rkdknqtnyL tGLqPFTEYV ialRCavkes	
Mus HPR1	12	LrFRTvNS.s rWteVnF.en ck...qvcnL tGLqaPFTEYV lalRfrfnds	
gp130	8	iqYRTkda.s tWsqip.ped tastrssftv qdLkPFTEYV FrIRCmkEdg	
GCSFR	9	Lrhkpqrgea sWalVg...p lplealqyeL cGLlPaTaYt lQIRCirwpl	
Hs HPR2	21	mRYkattnqt .WnvkeF..d tnftvvgqse fyLePnikYV FQvRCq.Etg	
IL-12RB2	7	LRyRpsNSrl .Wnm..v..N vtkakgrhdL ldLkPFTEYe FQIssklhly	
LIF-R	6	ieikksNSvq eqrnVti.kg venssylvaL dkLnPyTlyt FrIRCstEtf	
consensus		LRYRT-NS-- -W--V-F--N -----L -GL-PFTEYV FOIRC--E--	
		222	261
Hs HPR1	4	K.fWSDWSqE kmgmTeEEaP c.....gLe lW...RvLkP aeadGrRpVr	
Mus HPR1	12	r.YWSkWSkE etrvTmEEvP h.....vLD lW...RileP admnGdRkVr	
gp130	8	KGYWSDWSeE asgiTyEdrp sk....aps fW...ykiDP shtqGyRtVq	
GCSFR	9	pGhWSDWSps lelRtTeraP tv....rLD TWwrrqRqLDP .....RtVq	
Hs HPR2	21	KrYWqpWSSl ffnkTpEtvp qvtskafqhd TWns~~~~~	
IL-12RB2	7	KGsWSDWSes lraqTpEEeP ..tgml...D vWymkRhId. ....ysrqgis	
LIF-R	6	.wkWSkWSnk kqhlTtEasP sk....gpD TWrew.... ..ssdgknli	
consensus		KGYWSDWS-E ----T-EE-P -----LD TW---R-LDP ----G-R-V-	
		262	310
Hs HPR1	4	LlWKkargap vleKtLGYni wyypesnTn. LTETmNtTng glelhLgges	
Mus HPR1	12	LlWKkargap vleKtFGYhi qyfaensTn. LTEinNiTtg qyellLmsqa	
gp130	8	LvWKtLppfE AnGKILdYev tltrwkshl. qnytvNaT.. kltvnLtnr	
GCSFR	9	LfWKpvPleE dsGrIqGYvV swrpsggaga ilplcNtTel sctfhLpsea	
IL-12RB2	7	LfWKnLsvsE ArGKILhYqV tlgeltggka mTqnitghts wttviprtgn	
LIF-R	6	iyWKpLPine AnGKILsYnV scssdeeTgs LsEipd.pgh kaeirLdknd	
consensus		L-WK-LP--E A-GKILGY-V -----T-- LTE--N-T-- ----L----	
		311	359
Hs HPR1	4	fwVSmisyNS lGKSpatLr IPaigEksfq cievmaAcva ed.gLvVkWQ	
Mus HPR1	12	hsVSVtsfNS lGKSqetiLr IPdvhEktfq yiksmqAyia ep.lLvVnWQ	
gp130	8	ylatltvrNl vGKSdaavLt IPacdfqath pvmdlkAfpk dn.mLwVeWt	
GCSFR	9	qeValvAyNS agTSrPTpv. .vfsEsrgp altrlhAmar dphsLwVgWe	
IL-12RB2	7	waVaVsAaNS kGSSlPTrin ImnlCEagll aprqvsAnse gmdnilVtWQ	
LIF-R	6	yiiSVvAkNS vGsSpSkia smeipnddl. ...kieqvgv mgkgilltWh	
consensus		--VSV-A-NS -GKS-PT-L- IP---E--- ----A--- ----L-V-WQ	

		360	404
Hs HPR1	4	ssal...dVn twmIEWfpdv d.SePttsW e.svSqaTnw TIcqDkLKPF	
Mus HPR1	12	ssip...aVd twivEWlpea amSkfpalsW e.svSqvtnw TIEqDkLKPF	
gp130	8	tPre...sVk kYileWcvls dka.PcitdW q.qedgtvhr TylrgNLaes	
GCSFR	9	pPnp...wpq gYVIEWglgp psasnsnktW rmeqngratg flIkeNirPF	
IL-12RB2	7	pPrkdpsaVq eYVvEWrelh pggdtqvpln wlrsrpyvns aliseNiKsy	
LIF-R	6	...ydpnmtc dYVIkWc.ns srSePclmdW rkvpSnsTet vIesDefrPg	
consensus		-P-----V- -YVIEW---- --S-P----W ----S--T-- TI--DNLKPF	
		405	454
Hs HPR1	4	wCYNISVYPm lhDkvGePyS IqAYaKEgvP SeGPEtkVEn IGvktvtItW	
Mus HPR1	12	tCYNISVYPv lghrvGePyS IqAYaKEgtP lkGPEtrVEn IGlrAtItW	
gp130	8	kCYLIItVtPv yaDgpGsPeS IkAYlKgapP SkGPTvrtkk vGKneAvleW	
GCSFR	9	qlYeIiVtPl ygDtmGpsqh vyAYsqEmAP ShaPElhkh IGKtwAqleW	
IL-12RB2	7	iCYeIrVYal sgDq.GgcsS IlgnsKhkAP lsGPhinait eeKgsilIsW	
LIF-R	6	irYNfflygc rnqgyqlrS migYieElAP ivaPnftVEd tsadsilvkW	
consensus		-CYNI-VYP- --D--G-P-S I-AY-KE-AP S-GPE--VE- IGK--A-I-W	
		455	489
Hs HPR1	4	keIPksErkG iicNYTIFYq aeGGkgfSKt .....VN....SSi	
Mus HPR1	12	keIPksarnG FinNYTIFYq aeGGkelSKt .....VN....Sha	
gp130	8	dqlPVdvqnG FirNYTIFYr tiiGnetavn .....Vd....SSH	
GCSFR	9	vpePpelgks plthYTIFwt naqngsfSai .....lN....aSS	
IL-12RB2	7	nsIPVqEqmG clIhYrIywk erdsnsqpql .....ceipyrvSq	
LIF-R	6	edIPVeElrG FlrgY.lfyf gkGerdtSKm rvlesgrsdi kvknitdiSq	
consensus		--IPV-E--G F--NYTIFY- --GG---SK- -----VN----SS-	
		490	539
Hs HPR1	4	lqygLeSLkr kTSYiVqvMA sTsAGGTNGt sinFkTLsfS VFEIilItsL	
Mus HPR1	12	lqcdLeSLtr rTSYtVvwMA sTrAGGTNGv rinFkTLsIS VFEvlltsL	
gp130	8	teytLsSLts dTlYmVrmaA yTdeGGkdGp eftFtTpKfa ggEieaIvvp	
GCSFR	9	rgfvLhgLep aslyhihlMA asqAGaTNst vltlmTLtpe gSElhiIlgL	
IL-12RB2	7	nshpinSLqp rvtYvlwmtA lTaAGesshg nerefclgk anwmavfaps	
LIF-R	6	ktlriadLgg kTSYhlvlrA yTdgGvgpek smyvvtkenS VglIiaIlip	
consensus		----L-SL-- -TSY-V--MA -T-AGGTNG- ---F-TL--S V-EI--I--L	

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**Table 2: Box 1 and Box 2 motifs in the intracellular domains of HPR1, HPR2, and other hematopoietin receptors**

	SEQ ID NO	Box 1 Motif	Box 2 Motif
Hs HPR1	4	563-thlcWPtVNP-573	631-eifTdeArtgg-641
Mus HPR1	12	517-tpLccPDVNP-527	582-VvlTEEAqKgg-592
HPR2	21	393-pkwlyeDiPNm-403	430-VdpmiteiKei-440
LIF-R	6	866-KetfyPDiPNP-876	910-VleTrsAfpKi-920
gp130	8	648-KkhiWPnVPdP-658	693-VveiEandKKp-703
GCSFR	9	655-KnplWPsVPdP-665	696-ltvLBEdeKKp-706
consensus		K---WPDVNP	V--TEEA-KK-

**10 Table 3: Box 3 motifs in the intracellular domains of HPR2 and other hematopoietin receptors**

	SEQ ID NO	Box 3 Motif
HPR2 (first occurrence)	21	478-PdIntGYKPQisnf-491
HPR2 (second occurrence)	21	605-lpsintYfPQniLe-618
LIF-R	6	995-PVggaGYKPQmhLp-1008
gp130	8	693-tVvhsGYrhQvpsv-774
GCSFR	9	696-PtLvqtYvlQgdpr-734
consensus residues		PVL--GYKPQ--L-

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**EXAMPLE 2: Monoclonal Antibodies That Bind Polypeptides of the Invention**

This example illustrates a method for preparing monoclonal antibodies that bind HPR1 or HPR2 polypeptides. Suitable immunogens that may be employed in generating such antibodies include, but are not limited to, purified HPR1 or HPR2 polypeptide or an immunogenic fragment thereof. Purified HPR1 or HPR2 polypeptide can be used to generate monoclonal antibodies immunoreactive therewith, using conventional techniques such as those described in U.S. Patent 4,411,993. Briefly, mice are immunized with HPR1 or HPR2 polypeptide immunogen emulsified in complete Freund's adjuvant, and injected in amounts ranging from about 10 to about 100 micrograms subcutaneously or intraperitoneally. Ten to twelve days later, the immunized animals are boosted with additional HPR1 or HPR2 polypeptide emulsified in incomplete Freund's adjuvant. Mice are periodically boosted thereafter on a weekly to bi-weekly immunization schedule. Serum samples are periodically taken by retro-orbital bleeding or tail-tip excision to test for anti-HPR1 or anti-HPR2 antibodies by dot blot assay, ELISA (Enzyme-Linked Immunosorbent Assay), or inhibition of binding of HPR1 or HPR2 polypeptide to an HPR1 and/or HPR2 binding partner.

Following detection of an appropriate antibody titer, positive animals are provided one last intravenous injection of HPR1 or HPR2 polypeptide in saline. Three to four days later, the animals are sacrificed, spleen cells harvested, and spleen cells are fused to a murine myeloma cell line, *e.g.*, NS1 or preferably P3x63Ag8.653 (ATCC CRL 1580). Fusions generate hybridoma cells, which are plated in multiple microtiter plates in a HAT (hypoxanthine, aminopterin and thymidine) selective medium to inhibit proliferation of non-fused cells, myeloma hybrids, and spleen cell hybrids.

The hybridoma cells are screened by ELISA for reactivity against purified HPR1 or HPR2 polypeptide by adaptations of the techniques disclosed in Engvall et al., (*Immunochem.* 8:871, 1971) and in U.S. Patent 4,703,004. A preferred screening technique is the antibody capture technique described in Beckmann et al., (*J. Immunol.* 144:4212, 1990). Positive hybridoma cells can be injected intraperitoneally into syngeneic BALB/c mice to produce ascites containing high concentrations of anti-HPR1 or anti-HPR2 monoclonal antibodies. Alternatively, hybridoma cells can be grown *in vitro* in flasks or roller bottles by various techniques. Monoclonal antibodies produced in mouse ascites can be purified by ammonium sulfate precipitation, followed by gel exclusion chromatography. Alternatively, affinity chromatography based upon binding of antibody to Polypeptide A or Polypeptide G can also be used, as can affinity chromatography based upon binding to HPR1 or HPR2 polypeptide.

**EXAMPLE 3****Antisense Inhibition of HPR1 and/or HPR2 Expression**

In accordance with the present invention, a series of oligonucleotides are designed to target different regions of HPR1 and/or HPR2 human or murine mRNA molecules, using the nucleotide sequences of SEQ ID NOs 3, 5, 19, 20, 22, 24, 28, and 29 as the bases for the design of the oligonucleotides. The oligonucleotides are selected to be approximately 10, 12, 15, 18, or more

5 preferably 20 nucleotide residues in length, and to have a predicted hybridization temperature that is at least 37 degrees C. Preferably, the oligonucleotides are selected so that some will hybridize toward the 5' region of the mRNA molecule, others will hybridize to the coding region, and still others will hybridize to the 3' region of the mRNA molecule.

10 The oligonucleotides may be oligodeoxynucleotides, with phosphorothioate backbones (internucleoside linkages) throughout, or may have a variety of different types of internucleoside linkages. Generally, methods for the preparation, purification, and use of a variety of chemically modified oligonucleotides are described in U.S. Patent No. 5,948,680. Modified oligonucleosides may also be used in oligonucleotide synthesis, as well as mixed backbone compounds having, for instance, alternating MMI and P=O or P=S linkages, which are prepared as described in U.S. Pat. Nos. 15 5,378,825, 5,386,023, 5,489,677, 5,602,240 and 5,610,289. Formacetal- and thioformacetal-linked oligonucleosides may also be used and are prepared as described in U.S. Pat. Nos. 5,264,562 and 5,264,564; and ethylene oxide linked oligonucleosides may also be used and are prepared as described in U.S. Pat. No. 5,223,618. Peptide nucleic acids (PNAs) may be used as in the same manner as the oligonucleotides described above, and are prepared in accordance with any of the various procedures 20 referred to in Peptide Nucleic Acids (PNA): Synthesis, Properties and Potential Applications, Bioorganic & Medicinal Chemistry, 1996, 4, 5-23; and U.S. Pat. Nos. 5,539,082, 5,700,922, and 5,719,262. Chimeric oligonucleotides, oligonucleosides, or mixed oligonucleotides/oligonucleosides of the invention are synthesized according to U.S. Pat. No. 5,623,065.

25 The effect of antisense compounds on target nucleic acid expression can be tested in any of a variety of cell types provided that the target nucleic acid is present at measurable levels. This can be routinely determined using, for example, PCR or Northern blot analysis. Preferably, the effect of several different oligonucleotides should be tested simultaneously, where the oligonucleotides hybridize to different portions of the target nucleic acid molecules, in order to identify the oligonucleotides producing the greatest degree of inhibition of expression of the target nucleic acid. 30 Antisense modulation of HPR1 and/or HPR2 nucleic acid expression can be assayed in a variety of ways known in the art. For example, HPR1 and HPR2 mRNA levels can be quantitated by, e.g., Northern blot analysis, competitive polymerase chain reaction (PCR), or real-time PCR (RT-PCR). Real-time quantitative PCR is presently preferred. RNA analysis can be performed on total cellular RNA or poly(A)+ mRNA. Methods of RNA isolation and Northern blot analysis are taught in, for example, Ausubel, F. M. et al., Current Protocols in Molecular Biology, Volume 1, pp. 4.1.1-4.2.9 and 4.5.1-4.5.3, John Wiley & Sons, Inc., 1996. Real-time quantitative (PCR) can be conveniently 35 accomplished using the commercially available ABI PRISM 7700 Sequence Detection System, available from PE-Applied Biosystems, Foster City, Calif. and used according to manufacturer's instructions. Other methods of quantitative PCR analysis are also known in the art. HPR1 and HPR2 40 protein levels can be quantitated in a variety of ways well known in the art, such as immunoprecipitation, Western blot analysis (immunoblotting), ELISA, or fluorescence-activated cell sorting (FACS). Antibodies directed to HPR1 and/or HPR2 polypeptides can be prepared via

5 conventional antibody generation methods such as those described herein. Immunoprecipitation methods, Western blot (immunoblot) analysis, and enzyme-linked immunosorbent assays (ELISA) are standard in the art (see, for example, Ausubel, F. M. et al., Current Protocols in Molecular Biology, Volume 2, pp. 10.16.1-10.16.11, 10.8.1-10.8.21, and 11.2.1-11.2.22, John Wiley & Sons, Inc., 1991).

10 All publications and patent applications cited in this specification are herein incorporated by reference as if each individual publication or patent application were specifically and individually indicated to be incorporated by reference. Although the foregoing invention has been described in some detail by way of illustration and example for purposes of clarity of understanding, it will be readily apparent to those of ordinary skill in the art in light of the teachings of this invention that certain changes and modifications may be made thereto without departing from the spirit or scope of  
15 the appended claims.

#### Sequences Presented in the Sequence Listing

SEQ ID NO	Type	Description
SEQ ID NO:1	Amino acid	Partial human HPR1 amino acid sequence
SEQ ID NO:2	Amino acid	Partial human HPR1 amino acid sequence
SEQ ID NO:3	Nucleotide	Human HPR1 cDNA sequence
SEQ ID NO:4	Amino acid	Human HPR1 amino acid sequence (745 amino acids)
SEQ ID NO:5	Nucleotide	Human HPR1 coding sequence
SEQ ID NO:6	Amino acid	Human LIF-R amino acid sequence (GenBank NP_002301)
SEQ ID NO:7	Amino acid	Human IL-12RB2 amino acid sequence (GenBank NP_001550)
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SEQ ID NO:12	Amino acid	Mus musculus HPR1 amino acid sequence
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SEQ ID NO:14	Amino acid	Possible 652-aa human HPR1 variant (WO 00/75314)
SEQ ID NO:15	Amino acid	Possible 662-aa human HPR1 variant (WO 00/75314)
SEQ ID NO:16	Amino acid	Portion of possible alternatively spliced form of human HPR2
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SEQ ID NO:18	Amino acid	Portion of possible alternatively spliced form of human HPR2
SEQ ID NO:19	Nucleotide	Human HPR2 cDNA sequence - exons 1 through 11
SEQ ID NO:20	Nucleotide	Human HPR2 coding sequence (encodes 629-aa form)
SEQ ID NO:21	Amino acid	Human HPR2 amino acid sequence (629 amino acids)
SEQ ID NO:22	Nucleotide	Human HPR2-ex8-ex9 coding sequence (encodes 565-aa form)
SEQ ID NO:23	Amino acid	Human HPR2-ex8-ex9 amino acid sequence (565 amino acids)
SEQ ID NO:24	Nucleotide	Human HPR2-ex9 coding sequence (encodes 356-aa form)
SEQ ID NO:25	Amino acid	Human HPR2-ex9 amino acid sequence (356 amino acids)
SEQ ID NO:26	Amino acid	Possible 384-aa human HPR2 variant (WO 00/73451)
SEQ ID NO:27	Amino acid	Mus musculus HPR2 amino acid sequence
SEQ ID NO:28	Nucleotide	Mus musculus HPR1 coding sequence
SEQ ID NO:29	Nucleotide	Mus musculus HPR2 coding sequence



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CLAIMS

What is claimed is:

1. An isolated polypeptide having HPR1 polypeptide activity comprising an amino acid sequence selected from the group consisting of:

- (a) the amino acid sequence of SEQ ID NO:4;
- 10 (b) an amino acid sequence selected from the group consisting of: amino acids 652 though 745 of SEQ ID NO:4, a fragment of the sequence of amino acids 652 though 745 of SEQ ID NO:4 comprising at least 20 contiguous amino acids; a fragment of the sequence of amino acids 652 though 745 of SEQ ID NO:4 comprising at least 30 contiguous amino acids; a fragment of the sequence of amino acids 652 though 745 of SEQ ID NO:4 that is at least 25% of the length of the sequence of amino acids 652 though 745 of SEQ ID NO:4; a fragment of the sequence of amino acids 652 though 745 of SEQ ID NO:4 that is at least 50% of the length of the sequence of amino acids 652 though 745 of SEQ ID NO:4; and a fragment of the sequence of amino acids 652 though 745 of SEQ ID NO:4 comprising at least eight contiguous amino acids and comprising at least one tyrosine residue;
- 15 (c) an amino acid sequence comprising at least 8 amino acids and sharing amino acid identity with the amino acid sequences of (b), wherein the percent amino acid identity is selected from the group consisting of: at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, at least 97.5%, at least 99%, and at least 99.5%;
- 20 (d) an amino acid sequence comprising both an amino acid sequence of (b) or (c), and an amino acid sequence selected from the group consisting of: amino acids 1 through 55 of SEQ ID NO:1; amino acids 56 through 77 of SEQ ID NO:1; amino acids 5 through 40 of SEQ ID NO:2; amino acids 1 through 32 of SEQ ID NO:4; amino acids 1 through 241 of SEQ ID NO:4; amino acids 1 through 525 of SEQ ID NO:4; amino acids 20 through 32 of SEQ ID NO:4; amino acids 33 through 134 of SEQ ID NO:4; amino acids Xaa1 through Xaa2 of SEQ ID NO:4, wherein Xaa1 is selected from the group consisting of amino acids 33 through 43 of SEQ ID NO:4 and Xaa2 is selected from the group consisting of amino acids 228 through 241 of SEQ ID NO:4; amino acids 33 through 238 of SEQ ID NO:4; amino acids 33 through 241 of SEQ ID NO:4; amino acids 33 through 525 of SEQ ID NO:4; amino acids 33 through 745 of SEQ ID NO:4; amino acids 44 through 94 of SEQ ID NO:4; amino acids 139 through 241 of SEQ ID NO:4; amino acids 242 through 326 of SEQ ID NO:4; amino acids 242 through 514 of SEQ ID NO:4; amino acids 337 through 419 of SEQ ID NO:4; amino acids 433 through 514 of SEQ ID NO:4; amino acids 526 through 556 of SEQ ID NO:4; amino acids 533 through 552 of SEQ ID NO:4; amino acids 553 through 745 of SEQ ID NO:4; amino acids 557 through 745 of SEQ ID NO:4; amino acids 563 through 573 of SEQ ID NO:4; amino acids 563 through 641 of SEQ ID NO:4; amino acids 567 through 581 of SEQ ID NO:4; amino acids 588 through 639 of SEQ ID NO:4; amino acids 631 through 641 of SEQ ID NO:4; SEQ ID NO:10; and SEQ ID NO:11;
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- 5 (e) an amino acid sequence comprising both an amino acid sequence of (b) or (c), and a fragment of SEQ ID NO:4 comprising cytokine receptor domain amino acid sequences;
- (f) an allelic variant of any of (a)-(e); and
- (g) an amino acid sequence of (a)-(f), wherein a polypeptide comprising said amino acid sequence of (a)-(f) binds to an antibody that also binds to a polypeptide comprising an amino acid sequence of any of (b)-(c).
- 10

2. An isolated polypeptide having HPR1 polypeptide activity comprising an amino acid sequence selected from the group consisting of:

- (a) the amino acid sequence of SEQ ID NO:12;
- 15 (b) an amino acid sequence selected from the group consisting of: amino acids 633 through 726 of SEQ ID NO:12, a fragment of the sequence of amino acids 633 through 726 of SEQ ID NO:12 comprising at least 20 contiguous amino acids; a fragment of the sequence of amino acids 633 through 726 of SEQ ID NO:12 comprising at least 30 contiguous amino acids; a fragment of the sequence of amino acids 633 through 726 of SEQ ID NO:12 that is at least 25% of the length of the sequence of amino acids 633 through 726 of SEQ ID NO:12; a fragment of the sequence of amino acids 633 through 726 of SEQ ID NO:12 that is at least 50% of the length of the sequence of amino acids 633 through 726 of SEQ ID NO:12; and a fragment of the sequence of amino acids 633 through 726 of SEQ ID NO:12 comprising at least eight contiguous amino acids and comprising at least one tyrosine residue;
- 20 (c) an amino acid sequence comprising at least 8 amino acids and sharing amino acid identity with the amino acid sequences of (b), wherein the percent amino acid identity is selected from the group consisting of: at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, at least 97.5%, at least 99%, and at least 99.5%;
- 25 (d) an amino acid sequence comprising both an amino acid sequence of (b) or (c), and an amino acid sequence selected from the group consisting of: amino acids 1 through 28 of SEQ ID NO:12; amino acids 1 through 224 of SEQ ID NO:12; amino acids 1 through 509 of SEQ ID NO:12; amino acids 13 through 28 of SEQ ID NO:12; amino acids 29 through 124 of SEQ ID NO:12; amino acids Xaa1 through Xaa2 of SEQ ID NO:12, wherein Xaa1 is selected from the group consisting of amino acids 29 through 39 of SEQ ID NO:12 and Xaa2 is selected from the group consisting of amino acids 211 through 224 of SEQ ID NO:12; amino acids 29 through 128 of SEQ ID NO:12; amino acids 29 through 224 of SEQ ID NO:12; amino acids 29 through 509 of SEQ ID NO:12; amino acids 29 through 726 of SEQ ID NO:12; amino acids 129 through 224 of SEQ ID NO:12; amino acids 225 through 309 of SEQ ID NO:12; amino acids 225 through 499 of SEQ ID NO:12; amino acids 320 through 403 of SEQ ID NO:12; amino acids 417 through 508 of SEQ ID NO:12; amino acids 510 through 533 of SEQ ID NO:12; amino acids 517 through 532 of SEQ ID NO:12; amino acids 534 through 726 of SEQ ID NO:12; amino acids 547 through 557 of
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- 5 SEQ ID NO:12; amino acids 547 through 622 of SEQ ID NO:12; and amino acids 612 through 622 of SEQ ID NO:12;
- (e) an amino acid sequence comprising both an amino acid sequence of (b) or (c), and a fragment of SEQ ID NO:12 comprising cytokine receptor domain amino acid sequences;
- (f) an allelic variant of any of (a)-(e); and
- 10 (g) an amino acid sequence of (a)-(f), wherein a polypeptide comprising said amino acid sequence of (a)-(f) binds to an antibody that also binds to a polypeptide comprising an amino acid sequence of any of (b)-(c).
3. An isolated polypeptide having HPR2 polypeptide activity comprising an amino acid
- 15 sequence selected from the group consisting of:
- (a) SEQ ID NO:23;
- (b) SEQ ID NO:25;
- (c) an amino acid sequence selected from the group consisting of: an amino acid sequence comprising at least 20 contiguous amino acids of SEQ ID NO:23 and comprising the
- 20 contiguous amino acids 318 and 319 of SEQ ID NO:23; and amino acids 349 through 356 of SEQ ID NO:25;
- (d) an amino acid sequence comprising at least 8 amino acids and sharing amino acid identity with the amino acid sequences of (c), wherein the percent amino acid identity is selected from the group consisting of: at least 70%, at least 75%, at least 80%, at least 85%, at least 90%,
- 25 at least 95%, at least 97.5%, at least 99%, and at least 99.5%;
- (e) an amino acid sequence comprising both an amino acid sequence of (c) or (d), and an amino acid sequence selected from the group consisting of: amino acids 1 through 177 of SEQ ID NO:16; amino acids 216 through 245 of SEQ ID NO:16; SEQ ID NO:17; and SEQ ID NO:18;
- (f) an amino acid sequence comprising both an amino acid sequence of (c) or (d), and
- 30 amino acid sequences of any of (a)-(b) comprising cytokine receptor domain amino acid sequences;
- (g) an allelic variant of any of (a)-(f); and
- (h) an amino acid sequence of (a)-(g), wherein a polypeptide comprising said amino acid sequence of (a)-(g) binds to an antibody that also binds to a polypeptide comprising an amino acid
- 35 sequence of any of (c)-(d).
4. An isolated polypeptide having HPR2 polypeptide activity comprising an amino acid sequence selected from the group consisting of:
- (a) SEQ ID NO:27;
- 40 (b) SEQ ID NO:27 from which amino acids 297 through 316 or amino acids 317 through 336 have been deleted;

- 5 (c) an amino acid sequence comprising 20 or more contiguous amino acids of (a) or (b);  
and  
(d) an amino acid sequence comprising 30 or more contiguous amino and sharing at least  
90% amino acid identity with the amino acid sequences of (a)-(b).
- 10 5. An isolated nucleic acid encoding a polypeptide of any of claims 1 through 4.
6. The nucleic acid of claim 5 comprising a nucleotide sequence selected from the group  
consisting of:
- 15 (a) SEQ ID NO:3;  
(b) SEQ ID NO:5;  
(c) nucleotides 132 through 2366 of SEQ ID NO:3; and  
(d) allelic variants of (a)-(c).
7. The nucleic acid of claim 5 comprising a nucleotide sequence selected from the group  
20 consisting of nucleotides 1 through 137 of SEQ ID NO:3, nucleotides 138 through 228 of SEQ ID  
NO:3, nucleotides 229 through 346 of SEQ ID NO:3, nucleotides 347 through 528 of SEQ ID NO:3,  
nucleotides 529 through 680 of SEQ ID NO:3, nucleotides 681 through 846 of SEQ ID NO:3,  
nucleotides 847 through 926 of SEQ ID NO:3, nucleotides 927 through 1143 of SEQ ID NO:3,  
nucleotides 1144 through 1326 of SEQ ID NO:3, nucleotides 1327 through 1428 of SEQ ID NO:3,  
25 nucleotides 1429 through 1575 of SEQ ID NO:3, nucleotides 1576 through 1716 of SEQ ID NO:3,  
nucleotides 1717 through 1810 of SEQ ID NO:3, nucleotides 1811 through 1892 of SEQ ID NO:3, and  
nucleotides 1893 through 2480 of SEQ ID NO:3.
8. The nucleic acid of claim 5 comprising a nucleotide sequence selected from the group  
30 consisting of:
- (a) SEQ ID NO:28; and  
(b) allelic variants of (a).
9. The nucleic acid of claim 5 comprising a nucleotide sequence selected from the group  
35 consisting of:
- (a) SEQ ID NO:19;  
(b) SEQ ID NO:20;  
(c) SEQ ID NO:22;  
(d) SEQ ID NO:24; and  
40 (d) allelic variants of (a)-(d).

- 5 10. The nucleic acid of claim 5 comprising a nucleotide sequence selected from the group consisting of: nucleotides 107 through 175 of SEQ ID NO:19, nucleotides 107 through 478 of SEQ ID NO:19, nucleotides 107 through 1060 of SEQ ID NO:19, nucleotides 107 through 1099 of SEQ ID NO:19, nucleotides 107 through 1171 of SEQ ID NO:19, nucleotides 176 through 478 of SEQ ID NO:19, nucleotides 176 through 1099 of SEQ ID NO:19, nucleotides 176 through 1171 of SEQ ID NO:19, nucleotides 479 through 763 of SEQ ID NO:19, nucleotides 479 through 1099 of SEQ ID NO:19, nucleotides 503 through 1033 of SEQ ID NO:19, nucleotides 776 through 1066 of SEQ ID NO:19, nucleotides 776 through 1099 of SEQ ID NO:19, nucleotides 1061 through 1801 of SEQ ID NO:19, nucleotides 1232 through 1993 of SEQ ID NO:19, nucleotides 1283 through 1426 of SEQ ID NO:19, nucleotides 1283 through 1960 of SEQ ID NO:19, and nucleotides 1295 through 1939 of SEQ ID NO:19.
- 10 11. The nucleic acid of claim 5 comprising the nucleotide sequence of SEQ ID NO:29.
12. An isolated genomic nucleic acid corresponding to the nucleic acid of any of claims 5 to 11.
- 20 13. An expression vector comprising at least one nucleic acid according to any of claims 5 through 12.
14. A recombinant host cell comprising at least one nucleic acid according to any of claims 5 through 12.
- 25 15. The recombinant host cell of claim 14, wherein the nucleic acid is integrated into the host cell genome.
- 30 16. A process for producing a polypeptide encoded by the nucleic acid of any of claims 5 through 12, comprising culturing a recombinant host cell under conditions promoting expression of said polypeptide, wherein the recombinant host cell comprises at least one nucleic acid according to any of claims 5 through 12.
- 35 17. The process of claim 16 further comprising purifying said polypeptide.
18. The polypeptide produced by the process of claim 17.
19. An isolated antibody that binds to the polypeptide of any of claims 1 through 4 or claim 18.
- 40 20. The antibody of claim 19 wherein the antibody is a monoclonal antibody.

- 5      21.      The antibody of claim 19 wherein the antibody is a human antibody.
22.      The antibody of claim 19 wherein the antibody is a humanized antibody.
23.      The antibody of claim 19 wherein the antibody inhibits the activity of the polypeptide of any  
10      of claims 1 through 4 or claim 18.
24.      A method of designing an inhibitor of the polypeptide of any of claims 1 through 4 or claim  
18, the method comprising the steps of determining the three-dimensional structure of such  
polypeptide, analyzing the three-dimensional structure for the likely binding sites of substrates,  
15      synthesizing a molecule that incorporates a predicted reactive site, and determining the polypeptide-  
inhibiting activity of the molecule.
25.      A method for identifying compounds that alter HPR1 or HRP2 polypeptide activity  
comprising  
20      (a)      mixing a test compound with the polypeptide of any of claims 1 through 4 or claim  
18; and  
          (b)      determining whether the test compound alters the HPR1 or HRP2 polypeptide  
activity of said polypeptide.
- 25      26.      A method for identifying compounds that inhibit the binding activity of HPR1 or HRP2  
polypeptides comprising (a) mixing a test compound with the polypeptide of any of claims 1 through 4  
or claim 18 and a binding partner of said polypeptide; and (b) determining whether the test compound  
inhibits the binding activity of said polypeptide.
- 30      27.      A method for increasing ligand-binding activity comprising providing at least one compound  
selected from the group consisting of the polypeptide of any of claims 1 through 4 or claim 18 and  
agonists of said polypeptides.
- 35      28.      The method of claim 27 wherein the method comprises increasing ligand-binding activity in a  
patient by administering to said patient at least one compound selected from the group consisting of the  
polypeptide of any of claims 1 through 4 or claim 18 and agonists of said polypeptides.
29.      A method for decreasing ligand-binding activity comprising providing at least one antagonist  
of the polypeptide of any of claims 1 through 4 or claim 18.

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- 5      30.      The method of claim 29 wherein the method comprises decreasing ligand-binding activity in a patient by administering at least one antagonist of the polypeptide of any of claims 1 through 4 or claim 18 to said patient.
- 10      31.      The method of claim 29 wherein the antagonist is an antibody that inhibits the activity of said polypeptide.
- 15      32.      A method for treating a cell proliferation condition comprising administering at least one compound selected from the group consisting of the polypeptide of any of claims 1 through 4 or claim 18 and agonists of said polypeptides.
- 20      33.      The method of claim 32 wherein the cell proliferation condition is selected from the group consisting of pancytopenia, leukopenia, anemia, thrombocytopenia, neurodegenerative disorders, and osteoporosis resulting from a lack of bone-forming cells.
- 25      34.      A method for treating a cell proliferation condition comprising administering an antagonist of the polypeptide of any of claims 1 through 4 or claim 18.
35.      The method of claim 34 wherein the cell proliferation condition is selected from the group consisting of leukemia, tumour metastasis, and osteoporosis resulting from an excess of bone-resorbing cells.

## SEQUENCE LISTING

<110> Immunex Corporation  
 Cosman, David J.  
 Mosley, Bruce A.  
 Bird, Timothy A.  
 DuBose, Robert F.  
 Wiley, Steven R.

<120> HEMATOPOIETIN RECEPTORS HPR1 AND HPR2

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Gln Glu Asn Asn Leu Gly Gly Glu Lys Asn Gly Tyr Val Thr Cys Pro  
645 650 655

Phe Arg Pro Asp Cys Pro Leu Gly Lys Ser Phe Glu Glu Leu Pro Val  
660 665 670

Ser Pro Glu Ile Pro Pro Gly Lys Ser Gln Tyr Leu Arg Ser Arg Met  
675 680 685

Pro Glu Gly Thr Arg Pro Glu Ala Lys Glu Gln Leu Leu Phe Ser Gly  
690 695 700

Gln Ser Leu Val Pro Asp His Leu Cys Glu Glu Gly Ala Pro Asn Pro  
705 710 715 720

Tyr Leu Lys Asn Ser Val Thr Ala Arg Glu Phe Leu Val Ser Glu Lys  
725 730 735

Leu Pro Glu His Thr Lys Gly Glu Val  
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<211> 2238

<212> DNA

<213> Homo sapiens

<400> 5

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atttcctgtg tctactacta taggaaaaat ttaacctgca cttggagtcc aggaaaggaa 180

accagttata ccagtacac agttaagaga acttacgctt ttggagaaaa acatgataat 240

tgtacaacca atagttctac aagtgaagaat cgtgcttcgt gctctttttt ccttccaaga 300

ataacgatcc cagataatta taccattgag gtggaagctg aaaatggaga tgggtgtaatt 360

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gagttggcgc	ctgtttcatc	tgatttaaaa	tacacacttc	gattcaggac	agtcaacagt	540
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cagcttgaac	tgcatctggg	aggcgagagc	ttttgggtgt	ctatgatttc	ttataattct	960
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ttaaaacctt	tctggtgcta	taacatctct	gtgtatccaa	tgttgcatga	caaagttggc	1260
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aaattgactc	atctgtgttg	gcccaccggt	cccaaccctg	ctgaaagtag	tatagccaca	1740
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caggaaaaca	atttaggagg	ggaaaagaat	gggtatgtga	cctgccccct	caggcctgat	1980
tgtcccctgg	ggaaaagttt	tgaggagctc	ccagtttcac	ctgagattcc	gccccgaaaa	2040
tcccaatacc	tacgttcgag	gatgccagag	gggaccgcgc	cagaagccaa	agagcagctt	2100
ctcttttctg	gtcaaagttt	agtaccagat	catctgtgtg	aggaaggagc	cccaaatcca	2160

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 accaaggag aagtctaa 2238

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 <212> PRT  
 <213> Homo sapiens

<400> 6

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Asn Lys Arg Met Arg Thr Ala Ser Asn Phe Gln Trp Leu Leu Ser Thr  
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Phe Ile Leu Leu Tyr Leu Met Asn Gln Val Asn Ser Gln Lys Lys Gly  
 35 40 45

Ala Pro His Asp Leu Lys Cys Val Thr Asn Asn Leu Gln Val Trp Asn  
 50 55 60

Cys Ser Trp Lys Ala Pro Ser Gly Thr Gly Arg Gly Thr Asp Tyr Glu  
 65 70 75 80

Val Cys Ile Glu Asn Arg Ser Arg Ser Cys Tyr Gln Leu Glu Lys Thr  
 85 90 95

Ser Ile Lys Ile Pro Ala Leu Ser His Gly Asp Tyr Glu Ile Thr Ile  
 100 105 110

Asn Ser Leu His Asp Phe Gly Ser Ser Thr Ser Lys Phe Thr Leu Asn  
 115 120 125

Glu Gln Asn Val Ser Leu Ile Pro Asp Thr Pro Glu Ile Leu Asn Leu  
 130 135 140

Ser Ala Asp Phe Ser Thr Ser Thr Leu Tyr Leu Lys Trp Asn Asp Arg  
 145 150 155 160

Gly Ser Val Phe Pro His Arg Ser Asn Val Ile Trp Glu Ile Lys Val  
 165 170 175

Leu Arg Lys Glu Ser Met Glu Leu Val Lys Leu Val Thr His Asn Thr  
 180 185 190

Thr Leu Asn Gly Lys Asp Thr Leu His His Trp Ser Trp Ala Ser Asp

195					200					205					
Met	Pro	Leu	Glu	Cys	Ala	Ile	His	Phe	Val	Glu	Ile	Arg	Cys	Tyr	Ile
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Asp	Asn	Leu	His	Phe	Ser	Gly	Leu	Glu	Glu	Trp	Ser	Asp	Trp	Ser	Pro
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Val	Lys	Asn	Ile	Ser	Trp	Ile	Pro	Asp	Ser	Gln	Thr	Lys	Val	Phe	Pro
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Gln	Asp	Lys	Val	Ile	Leu	Val	Gly	Ser	Asp	Ile	Thr	Phe	Cys	Cys	Val
			260					265					270		
Ser	Gln	Glu	Lys	Val	Leu	Ser	Ala	Leu	Ile	Gly	His	Thr	Asn	Cys	Pro
		275					280					285			
Leu	Ile	His	Leu	Asp	Gly	Glu	Asn	Val	Ala	Ile	Lys	Ile	Arg	Asn	Ile
	290					295					300				
Ser	Val	Ser	Ala	Ser	Ser	Gly	Thr	Asn	Val	Val	Phe	Thr	Thr	Glu	Asp
305					310					315					320
Asn	Ile	Phe	Gly	Thr	Val	Ile	Phe	Ala	Gly	Tyr	Pro	Pro	Asp	Thr	Pro
				325					330					335	
Gln	Gln	Leu	Asn	Cys	Glu	Thr	His	Asp	Leu	Lys	Glu	Ile	Ile	Cys	Ser
			340					345					350		
Trp	Asn	Pro	Gly	Arg	Val	Thr	Ala	Leu	Val	Gly	Pro	Arg	Ala	Thr	Ser
		355					360					365			
Tyr	Thr	Leu	Val	Glu	Ser	Phe	Ser	Gly	Lys	Tyr	Val	Arg	Leu	Lys	Arg
	370					375					380				
Ala	Glu	Ala	Pro	Thr	Asn	Glu	Ser	Tyr	Gln	Leu	Leu	Phe	Gln	Met	Leu
385					390					395					400
Pro	Asn	Gln	Glu	Ile	Tyr	Asn	Phe	Thr	Leu	Asn	Ala	His	Asn	Pro	Leu
				405					410					415	
Gly	Arg	Ser	Gln	Ser	Thr	Ile	Leu	Val	Asn	Ile	Thr	Glu	Lys	Val	Tyr
			420					425					430		
Pro	His	Thr	Pro	Thr	Ser	Phe	Lys	Val	Lys	Asp	Ile	Asn	Ser	Thr	Ala
		435					440					445			



Val Lys Leu Ser Trp His Leu Pro Gly Asn Phe Ala Lys Ile Asn Phe  
 450 455 460

Leu Cys Glu Ile Glu Ile Lys Lys Ser Asn Ser Val Gln Glu Gln Arg  
 465 470 475 480

Asn Val Thr Ile Lys Gly Val Glu Asn Ser Ser Tyr Leu Val Ala Leu  
 485 490 495

Asp Lys Leu Asn Pro Tyr Thr Leu Tyr Thr Phe Arg Ile Arg Cys Ser  
 500 505 510

Thr Glu Thr Phe Trp Lys Trp Ser Lys Trp Ser Asn Lys Lys Gln His  
 515 520 525

Leu Thr Thr Glu Ala Ser Pro Ser Lys Gly Pro Asp Thr Trp Arg Glu  
 530 535 540

Trp Ser Ser Asp Gly Lys Asn Leu Ile Ile Tyr Trp Lys Pro Leu Pro  
 545 550 555 560

Ile Asn Glu Ala Asn Gly Lys Ile Leu Ser Tyr Asn Val Ser Cys Ser  
 565 570 575

Ser Asp Glu Glu Thr Gln Ser Leu Ser Glu Ile Pro Asp Pro Gln His  
 580 585 590

Lys Ala Glu Ile Arg Leu Asp Lys Asn Asp Tyr Ile Ile Ser Val Val  
 595 600 605

Ala Lys Asn Ser Val Gly Ser Ser Pro Pro Ser Lys Ile Ala Ser Met  
 610 615 620

Glu Ile Pro Asn Asp Asp Leu Lys Ile Glu Gln Val Val Gly Met Gly  
 625 630 635 640

Lys Gly Ile Leu Leu Thr Trp His Tyr Asp Pro Asn Met Thr Cys Asp  
 645 650 655

Tyr Val Ile Lys Trp Cys Asn Ser Ser Arg Ser Glu Pro Cys Leu Met  
 660 665 670

Asp Trp Arg Lys Val Pro Ser Asn Ser Thr Glu Thr Val Ile Glu Ser  
 675 680 685

Asp Glu Phe Arg Pro Gly Ile Arg Tyr Asn Phe Phe Leu Tyr Gly Cys  
 690 695 700

Arg Asn Gln Gly Tyr Gln Leu Leu Arg Ser Met Ile Gly Tyr Ile Glu  
 705 710 715 720

Glu Leu Ala Pro Ile Val Ala Pro Asn Phe Thr Val Glu Asp Thr Ser  
 725 730 735

Ala Asp Ser Ile Leu Val Lys Trp Glu Asp Ile Pro Val Glu Glu Leu  
 740 745 750

Arg Gly Phe Leu Arg Gly Tyr Leu Phe Tyr Phe Gly Lys Gly Glu Arg  
 755 760 765

Asp Thr Ser Lys Met Arg Val Leu Glu Ser Gly Arg Ser Asp Ile Lys  
 770 775 780

Val Lys Asn Ile Thr Asp Ile Ser Gln Lys Thr Leu Arg Ile Ala Asp  
 785 790 795 800

Leu Gln Gly Lys Thr Ser Tyr His Leu Val Leu Arg Ala Tyr Thr Asp  
 805 810 815

Gly Gly Val Gly Pro Glu Lys Ser Met Tyr Val Val Thr Lys Glu Asn  
 820 825 830

Ser Val Gly Leu Ile Ile Ala Ile Leu Ile Pro Val Ala Val Ala Val  
 835 840 845

Ile Val Gly Val Val Thr Ser Ile Leu Cys Tyr Arg Lys Arg Glu Trp  
 850 855 860

Ile Lys Glu Thr Phe Tyr Pro Asp Ile Pro Asn Pro Glu Asn Cys Lys  
 865 870 875 880

Ala Leu Gln Phe Gln Lys Ser Val Cys Glu Gly Ser Ser Ala Leu Lys  
 885 890 895

Thr Leu Glu Met Asn Pro Cys Thr Pro Asn Asn Val Glu Val Leu Glu  
 900 905 910

Thr Arg Ser Ala Phe Pro Lys Ile Glu Asp Thr Glu Ile Ile Ser Pro  
 915 920 925

Val Ala Glu Arg Pro Glu Asp Arg Ser Asp Ala Glu Pro Glu Asn His  
 930 935 940

Val Val Val Ser Tyr Cys Pro Pro Ile Ile Glu Glu Glu Ile Pro Asn  
 945 950 955 960

Pro Ala Ala Asp Glu Ala Gly Gly Thr Ala Gln Val Ile Tyr Ile Asp  
 965 970 975

Val Gln Ser Met Tyr Gln Pro Gln Ala Lys Pro Glu Glu Glu Gln Glu  
 980 985 990

Asn Asp Pro Val Gly Gly Ala Gly Tyr Lys Pro Gln Met His Leu Pro  
 995 1000 1005

Ile Asn Ser Thr Val Glu Asp Ile Ala Ala Glu Glu Asp Leu Asp  
 1010 1015 1020

Lys Thr Ala Gly Tyr Arg Pro Gln Ala Asn Val Asn Thr Trp Asn  
 1025 1030 1035

Leu Val Ser Pro Asp Ser Pro Arg Ser Ile Asp Ser Asn Ser Glu  
 1040 1045 1050

Ile Val Ser Phe Gly Ser Pro Cys Ser Ile Asn Ser Arg Gln Phe  
 1055 1060 1065

Leu Ile Pro Pro Lys Asp Glu Asp Ser Pro Lys Ser Asn Gly Gly  
 1070 1075 1080

Gly Trp Ser Phe Thr Asn Phe Phe Gln Asn Lys Pro Asn Asp  
 1085 1090 1095

<210> 7

<211> 979

<212> PRT

<213> Homo sapiens

<400> 7

Met Ala Leu Phe Ala Val Phe Gln Thr Thr Phe Phe Leu Thr Leu Leu  
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Ser Leu Arg Thr Tyr Gln Ser Glu Val Leu Ala Glu Arg Leu Pro Leu  
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Thr Pro Val Ser Leu Lys Val Ser Thr Asn Ser Thr Arg Gln Ser Leu  
 35 40 45

His Leu Gln Trp Thr Val His Asn Leu Pro Tyr His Gln Glu Leu Lys  
 50 55 60  
 Met Val Phe Gln Ile Gln Ile Ser Arg Ile Glu Thr Ser Asn Val Ile  
 65 70 75 80  
 Trp Val Gly Asn Tyr Ser Thr Thr Val Lys Trp Asn Gln Val Leu His  
 85 90 95  
 Trp Ser Trp Glu Ser Glu Leu Pro Leu Glu Cys Ala Thr His Phe Val  
 100 105 110  
 Arg Ile Lys Ser Leu Val Asp Asp Ala Lys Phe Pro Glu Pro Asn Phe  
 115 120 125  
 Trp Ser Asn Trp Ser Ser Trp Glu Glu Val Ser Val Gln Asp Ser Thr  
 130 135 140  
 Gly Gln Asp Ile Leu Phe Val Phe Pro Lys Asp Lys Leu Val Glu Glu  
 145 150 155 160  
 Gly Thr Asn Val Thr Ile Cys Tyr Val Ser Arg Asn Ile Gln Asn Asn  
 165 170 175  
 Val Ser Cys Tyr Leu Glu Gly Lys Gln Ile His Gly Glu Gln Leu Asp  
 180 185 190  
 Pro His Val Thr Ala Phe Asn Leu Asn Ser Val Pro Phe Ile Arg Asn  
 195 200 205  
 Lys Gly Thr Asn Ile Tyr Cys Glu Ala Ser Gln Gly Asn Val Ser Glu  
 210 215 220  
 Gly Met Lys Gly Ile Val Leu Phe Val Ser Lys Val Leu Glu Glu Pro  
 225 230 235 240  
 Lys Asp Phe Ser Cys Glu Thr Glu Asp Phe Lys Thr Leu His Cys Thr  
 245 250 255  
 Trp Asp Pro Gly Thr Asp Thr Ala Leu Gly Trp Ser Lys Gln Pro Ser  
 260 265 270  
 Gln Ser Tyr Thr Leu Phe Glu Ser Phe Ser Gly Glu Lys Lys Leu Cys  
 275 280 285

Thr His Lys Asn Trp Cys Asn Trp Gln Ile Thr Gln Asp Ser Gln Glu  
 290 295 300

Thr Tyr Asn Phe Thr Leu Ile Ala Glu Asn Tyr Leu Arg Lys Arg Ser  
 305 310 315 320

Val Asn Ile Leu Phe Asn Leu Thr His Arg Val Tyr Leu Met Asn Pro  
 325 330 335

Phe Ser Val Asn Phe Glu Asn Val Asn Ala Thr Asn Ala Ile Met Thr  
 340 345 350

Trp Lys Val His Ser Ile Arg Asn Asn Phe Thr Tyr Leu Cys Gln Ile  
 355 360 365

Glu Leu His Gly Glu Gly Lys Met Met Gln Tyr Asn Val Ser Ile Lys  
 370 375 380

Val Asn Gly Glu Tyr Phe Leu Ser Glu Leu Glu Pro Ala Thr Glu Tyr  
 385 390 395 400

Met Ala Arg Val Arg Cys Ala Asp Ala Ser His Phe Trp Lys Trp Ser  
 405 410 415

Glu Trp Ser Gly Gln Asn Phe Thr Thr Leu Glu Ala Ala Pro Ser Glu  
 420 425 430

Ala Pro Asp Val Trp Arg Ile Val Ser Leu Glu Pro Gly Asn His Thr  
 435 440 445

Val Thr Leu Phe Trp Lys Pro Leu Ser Lys Leu His Ala Asn Gly Lys  
 450 455 460

Ile Leu Phe Tyr Asn Val Val Val Glu Asn Leu Asp Lys Pro Ser Ser  
 465 470 475 480

Ser Glu Leu His Ser Ile Pro Ala Pro Ala Asn Ser Thr Lys Leu Ile  
 485 490 495

Leu Asp Arg Cys Ser Tyr Gln Ile Cys Val Ile Ala Asn Asn Ser Val  
 500 505 510

Gly Ala Ser Pro Ala Ser Val Ile Val Ile Ser Ala Asp Pro Glu Asn  
 515 520 525

Lys Glu Val Glu Glu Glu Arg Ile Ala Gly Thr Glu Gly Gly Phe Ser  
 530 535 540

Leu Ser Trp Lys Pro Gln Pro Gly Asp Val Ile Gly Tyr Val Val Asp  
 545 550 555 560

Trp Cys Asp His Thr Gln Asp Val Leu Gly Asp Phe Gln Trp Lys Asn  
 565 570 575

Val Gly Pro Asn Thr Thr Ser Thr Val Ile Ser Thr Asp Ala Phe Arg  
 580 585 590

Pro Gly Val Arg Tyr Asp Phe Arg Ile Tyr Gly Leu Ser Thr Lys Arg  
 595 600 605

Ile Ala Cys Leu Leu Glu Lys Lys Thr Gly Tyr Ser Gln Glu Leu Ala  
 610 615 620

Pro Ser Asp Asn Pro His Val Leu Val Asp Thr Leu Thr Ser His Ser  
 625 630 635 640

Phe Thr Leu Ser Trp Lys Asp Tyr Ser Thr Glu Ser Gln Pro Gly Phe  
 645 650 655

Ile Gln Gly Tyr His Val Tyr Leu Lys Ser Lys Ala Arg Gln Cys His  
 660 665 670

Pro Arg Phe Glu Lys Ala Val Leu Ser Asp Gly Ser Glu Cys Cys Lys  
 675 680 685

Tyr Lys Ile Asp Asn Pro Glu Glu Lys Ala Leu Ile Val Asp Asn Leu  
 690 695 700

Lys Pro Glu Ser Phe Tyr Glu Phe Phe Ile Thr Pro Phe Thr Ser Ala  
 705 710 715 720

Gly Glu Gly Pro Ser Ala Thr Phe Thr Lys Val Thr Thr Pro Asp Glu  
 725 730 735

His Ser Ser Met Leu Ile His Ile Leu Leu Pro Met Val Phe Cys Val  
 740 745 750

Leu Leu Ile Met Val Met Cys Tyr Leu Lys Ser Gln Trp Ile Lys Glu  
 755 760 765

Thr Cys Tyr Pro Asp Ile Pro Asp Pro Tyr Lys Ser Ser Ile Leu Ser

770                                      775                                      780  
 Leu Ile Lys Phe Lys Glu Asn Pro His Leu Ile Ile Met Asn Val Ser  
 785                                      790                                      795                                      800  
 Asp Cys Ile Pro Asp Ala Ile Glu Val Val Ser Lys Pro Glu Gly Thr  
                                     805                                      810                                      815  
 Lys Ile Gln Phe Leu Gly Thr Arg Lys Ser Leu Thr Glu Thr Glu Leu  
                                     820                                      825                                      830  
 Thr Lys Pro Asn Tyr Leu Tyr Leu Leu Pro Thr Glu Lys Asn His Ser  
                                     835                                      840                                      845  
 Gly Pro Gly Pro Cys Ile Cys Phe Glu Asn Leu Thr Tyr Asn Gln Ala  
                                     850                                      855                                      860  
 Ala Ser Asp Ser Gly Ser Cys Gly His Val Pro Val Ser Pro Lys Ala  
 865                                      870                                      875                                      880  
 Pro Ser Met Leu Gly Leu Met Thr Ser Pro Glu Asn Val Leu Lys Ala  
                                     885                                      890                                      895  
 Leu Glu Lys Asn Tyr Met Asn Ser Leu Gly Glu Ile Pro Ala Gly Glu  
                                     900                                      905                                      910  
 Thr Ser Leu Asn Tyr Val Ser Gln Leu Ala Ser Pro Met Phe Gly Asp  
                                     915                                      920                                      925  
 Lys Asp Ser Leu Pro Thr Asn Pro Val Glu Ala Pro His Cys Ser Glu  
                                     930                                      935                                      940  
 Tyr Lys Met Gln Met Ala Val Ser Leu Arg Leu Ala Leu Pro Pro Pro  
 945                                      950                                      955                                      960  
 Thr Glu Asn Ser Ser Leu Ser Ser Ile Thr Leu Leu Asp Pro Gly Glu  
                                     965                                      970                                      975  
 His Tyr Cys

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 <211> 918  
 <212> PRT  
 <213> Homo sapiens

<400> 8

Met Leu Thr Leu Gln Thr Trp Val Val Gln Ala Leu Phe Ile Phe Leu  
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 Thr Thr Glu Ser Thr Gly Glu Leu Leu Asp Pro Cys Gly Tyr Ile Ser  
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 Pro Glu Ser Pro Val Val Gln Leu His Ser Asn Phe Thr Ala Val Cys  
 35 40 45  
 Val Leu Lys Glu Lys Cys Met Asp Tyr Phe His Val Asn Ala Asn Tyr  
 50 55 60  
 Ile Val Trp Lys Thr Asn His Phe Thr Ile Pro Lys Glu Gln Tyr Thr  
 65 70 75 80  
 Ile Ile Asn Arg Thr Ala Ser Ser Val Thr Phe Thr Asp Ile Ala Ser  
 85 90 95  
 Leu Asn Ile Gln Leu Thr Cys Asn Ile Leu Thr Phe Gly Gln Leu Glu  
 100 105 110  
 Gln Asn Val Tyr Gly Ile Thr Ile Ile Ser Gly Leu Pro Pro Glu Lys  
 115 120 125  
 Pro Lys Asn Leu Ser Cys Ile Val Asn Glu Gly Lys Lys Met Arg Cys  
 130 135 140  
 Glu Trp Asp Gly Gly Arg Glu Thr His Leu Glu Thr Asn Phe Thr Leu  
 145 150 155 160  
 Lys Ser Glu Trp Ala Thr His Lys Phe Ala Asp Cys Lys Ala Lys Arg  
 165 170 175  
 Asp Thr Pro Thr Ser Cys Thr Val Asp Tyr Ser Thr Val Tyr Phe Val  
 180 185 190  
 Asn Ile Glu Val Trp Val Glu Ala Glu Asn Ala Leu Gly Lys Val Thr  
 195 200 205  
 Ser Asp His Ile Asn Phe Asp Pro Val Tyr Lys Val Lys Pro Asn Pro  
 210 215 220  
 Pro His Asn Leu Ser Val Ile Asn Ser Glu Glu Leu Ser Ser Ile Leu  
 225 230 235 240



Lys	Leu	Thr	Trp	Thr	Asn	Pro	Ser	Ile	Lys	Ser	Val	Ile	Ile	Leu	Lys
				245					250					255	
Tyr	Asn	Ile	Gln	Tyr	Arg	Thr	Lys	Asp	Ala	Ser	Thr	Trp	Ser	Gln	Ile
			260					265					270		
Pro	Pro	Glu	Asp	Thr	Ala	Ser	Thr	Arg	Ser	Ser	Phe	Thr	Val	Gln	Asp
		275					280					285			
Leu	Lys	Pro	Phe	Thr	Glu	Tyr	Val	Phe	Arg	Ile	Arg	Cys	Met	Lys	Glu
	290					295					300				
Asp	Gly	Lys	Gly	Tyr	Trp	Ser	Asp	Trp	Ser	Glu	Glu	Ala	Ser	Gly	Ile
305					310					315					320
Thr	Tyr	Glu	Asp	Arg	Pro	Ser	Lys	Ala	Pro	Ser	Phe	Trp	Tyr	Lys	Ile
				325					330					335	
Asp	Pro	Ser	His	Thr	Gln	Gly	Tyr	Arg	Thr	Val	Gln	Leu	Val	Trp	Lys
			340					345					350		
Thr	Leu	Pro	Pro	Phe	Glu	Ala	Asn	Gly	Lys	Ile	Leu	Asp	Tyr	Glu	Val
		355					360					365			
Thr	Leu	Thr	Arg	Trp	Lys	Ser	His	Leu	Gln	Asn	Tyr	Thr	Val	Asn	Ala
	370					375					380				
Thr	Lys	Leu	Thr	Val	Asn	Leu	Thr	Asn	Asp	Arg	Tyr	Leu	Ala	Thr	Leu
385					390					395					400
Thr	Val	Arg	Asn	Leu	Val	Gly	Lys	Ser	Asp	Ala	Ala	Val	Leu	Thr	Ile
			405						410					415	
Pro	Ala	Cys	Asp	Phe	Gln	Ala	Thr	His	Pro	Val	Met	Asp	Leu	Lys	Ala
			420					425					430		
Phe	Pro	Lys	Asp	Asn	Met	Leu	Trp	Val	Glu	Trp	Thr	Thr	Pro	Arg	Glu
		435					440					445			
Ser	Val	Lys	Lys	Tyr	Ile	Leu	Glu	Trp	Cys	Val	Leu	Ser	Asp	Lys	Ala
	450					455					460				
Pro	Cys	Ile	Thr	Asp	Trp	Gln	Gln	Glu	Asp	Gly	Thr	Val	His	Arg	Thr
465					470					475					480
Tyr	Leu	Arg	Gly	Asn	Leu	Ala	Glu	Ser	Lys	Cys	Tyr	Leu	Ile	Thr	Val

					485					490					495	
Thr	Pro	Val	Tyr	Ala	Asp	Gly	Pro	Gly	Ser	Pro	Glu	Ser	Ile	Lys	Ala	
			500					505					510			
Tyr	Leu	Lys	Gln	Ala	Pro	Pro	Ser	Lys	Gly	Pro	Thr	Val	Arg	Thr	Lys	
		515					520					525				
Lys	Val	Gly	Lys	Asn	Glu	Ala	Val	Leu	Glu	Trp	Asp	Gln	Leu	Pro	Val	
	530					535					540					
Asp	Val	Gln	Asn	Gly	Phe	Ile	Arg	Asn	Tyr	Thr	Ile	Phe	Tyr	Arg	Thr	
545					550					555					560	
Ile	Ile	Gly	Asn	Glu	Thr	Ala	Val	Asn	Val	Asp	Ser	Ser	His	Thr	Glu	
			565					570						575		
Tyr	Thr	Leu	Ser	Ser	Leu	Thr	Ser	Asp	Thr	Leu	Tyr	Met	Val	Arg	Met	
			580					585					590			
Ala	Ala	Tyr	Thr	Asp	Glu	Gly	Gly	Lys	Asp	Gly	Pro	Glu	Phe	Thr	Phe	
		595					600					605				
Thr	Thr	Pro	Lys	Phe	Ala	Gln	Gly	Glu	Ile	Glu	Ala	Ile	Val	Val	Pro	
	610					615					620					
Val	Cys	Leu	Ala	Phe	Leu	Leu	Thr	Thr	Leu	Leu	Gly	Val	Leu	Phe	Cys	
625					630					635					640	
Phe	Asn	Lys	Arg	Asp	Leu	Ile	Lys	Lys	His	Ile	Trp	Pro	Asn	Val	Pro	
				645					650					655		
Asp	Pro	Ser	Lys	Ser	His	Ile	Ala	Gln	Trp	Ser	Pro	His	Thr	Pro	Pro	
			660					665					670			
Arg	His	Asn	Phe	Asn	Ser	Lys	Asp	Gln	Met	Tyr	Ser	Asp	Gly	Asn	Phe	
		675					680					685				
Thr	Asp	Val	Ser	Val	Val	Glu	Ile	Glu	Ala	Asn	Asp	Lys	Lys	Pro	Phe	
	690					695					700					
Pro	Glu	Asp	Leu	Lys	Ser	Leu	Asp	Leu	Phe	Lys	Lys	Glu	Lys	Ile	Asn	
705					710					715					720	
Thr	Glu	Gly	His	Ser	Ser	Gly	Ile	Gly	Gly	Ser	Ser	Cys	Met	Ser	Ser	
				725					730					735		

Ser Arg Pro Ser Ile Ser Ser Ser Asp Glu Asn Glu Ser Ser Gln Asn  
740 745 750

Thr Ser Ser Thr Val Gln Tyr Ser Thr Val Val His Ser Gly Tyr Arg  
755 760 765

His Gln Val Pro Ser Val Gln Val Phe Ser Arg Ser Glu Ser Thr Gln  
770 775 780

Pro Leu Leu Asp Ser Glu Glu Arg Pro Glu Asp Leu Gln Leu Val Asp  
785 790 795 800

His Val Asp Gly Gly Asp Gly Ile Leu Pro Arg Gln Gln Tyr Phe Lys  
805 810 815

Gln Asn Cys Ser Gln His Glu Ser Ser Pro Asp Ile Ser His Phe Glu  
820 825 830

Arg Ser Lys Gln Val Ser Ser Val Asn Glu Glu Asp Phe Val Arg Leu  
835 840 845

Lys Gln Gln Ile Ser Asp His Ile Ser Gln Ser Cys Gly Ser Gly Gln  
850 855 860

Met Lys Met Phe Gln Glu Val Ser Ala Ala Asp Ala Phe Gly Pro Gly  
865 870 875 880

Thr Glu Gly Gln Val Glu Arg Phe Glu Thr Val Gly Met Glu Ala Ala  
885 890 895

Thr Asp Glu Gly Met Pro Lys Ser Tyr Leu Pro Gln Thr Val Arg Gln  
900 905 910

Gly Gly Tyr Met Pro Gln  
915

<210> 9

<211> 836

<212> PRT

<213> Homo sapiens

<400> 9

Met Ala Arg Leu Gly Asn Cys Ser Leu Thr Trp Ala Ala Leu Ile Ile  
1 5 10 15

Leu Leu Leu Pro Gly Ser Leu Glu Glu Cys Gly His Ile Ser Val Ser  
 20 25 30

Ala Pro Ile Val His Leu Gly Asp Pro Ile Thr Ala Ser Cys Ile Ile  
 35 40 45

Lys Gln Asn Cys Ser His Leu Asp Pro Glu Pro Gln Ile Leu Trp Arg  
 50 55 60

Leu Gly Ala Glu Leu Gln Pro Gly Gly Arg Gln Gln Arg Leu Ser Asp  
 65 70 75 80

Gly Thr Gln Glu Ser Ile Ile Thr Leu Pro His Leu Asn His Thr Gln  
 85 90 95

Ala Phe Leu Ser Cys Cys Leu Asn Trp Gly Asn Ser Leu Gln Ile Leu  
 100 105 110

Asp Gln Val Glu Leu Arg Ala Gly Tyr Pro Pro Ala Ile Pro His Asn  
 115 120 125

Leu Ser Cys Leu Met Asn Leu Thr Thr Ser Ser Leu Ile Cys Gln Trp  
 130 135 140

Glu Pro Gly Pro Glu Thr His Leu Pro Thr Ser Phe Thr Leu Lys Ser  
 145 150 155 160

Phe Lys Ser Arg Gly Asn Cys Gln Thr Gln Gly Asp Ser Ile Leu Asp  
 165 170 175

Cys Val Pro Lys Asp Gly Gln Ser His Cys Cys Ile Pro Arg Lys His  
 180 185 190

Leu Leu Leu Tyr Gln Asn Met Gly Ile Trp Val Gln Ala Glu Asn Ala  
 195 200 205

Leu Gly Thr Ser Met Ser Pro Gln Leu Cys Leu Asp Pro Met Asp Val  
 210 215 220

Val Lys Leu Glu Pro Pro Met Leu Arg Thr Met Asp Pro Ser Pro Glu  
 225 230 235 240

Ala Ala Pro Pro Gln Ala Gly Cys Leu Gln Leu Cys Trp Glu Pro Trp  
 245 250 255

Gln Pro Gly Leu His Ile Asn Gln Lys Cys Glu Leu Arg His Lys Pro

260	265	270																	
Gln	Arg	Gly	Glu	Ala	Ser	Trp	Ala	Leu	Val	Gly	Pro	Leu	Pro	Leu	Glu				
		275					280					285							
Ala	Leu	Gln	Tyr	Glu	Leu	Cys	Gly	Leu	Leu	Pro	Ala	Thr	Ala	Tyr	Thr				
	290					295					300								
Leu	Gln	Ile	Arg	Cys	Ile	Arg	Trp	Pro	Leu	Pro	Gly	His	Trp	Ser	Asp				
305					310					315					320				
Trp	Ser	Pro	Ser	Leu	Glu	Leu	Arg	Thr	Thr	Glu	Arg	Ala	Pro	Thr	Val				
				325					330					335					
Arg	Leu	Asp	Thr	Trp	Trp	Arg	Gln	Arg	Gln	Leu	Asp	Pro	Arg	Thr	Val				
			340					345					350						
Gln	Leu	Phe	Trp	Lys	Pro	Val	Pro	Leu	Glu	Glu	Asp	Ser	Gly	Arg	Ile				
		355					360					365							
Gln	Gly	Tyr	Val	Val	Ser	Trp	Arg	Pro	Ser	Gly	Gln	Ala	Gly	Ala	Ile				
	370					375					380								
Leu	Pro	Leu	Cys	Asn	Thr	Thr	Glu	Leu	Ser	Cys	Thr	Phe	His	Leu	Pro				
385					390					395					400				
Ser	Glu	Ala	Gln	Glu	Val	Ala	Leu	Val	Ala	Tyr	Asn	Ser	Ala	Gly	Thr				
				405					410					415					
Ser	Arg	Pro	Thr	Pro	Val	Val	Phe	Ser	Glu	Ser	Arg	Gly	Pro	Ala	Leu				
			420					425					430						
Thr	Arg	Leu	His	Ala	Met	Ala	Arg	Asp	Pro	His	Ser	Leu	Trp	Val	Gly				
		435					440					445							
Trp	Glu	Pro	Pro	Asn	Pro	Trp	Pro	Gln	Gly	Tyr	Val	Ile	Glu	Trp	Gly				
	450					455					460								
Leu	Gly	Pro	Pro	Ser	Ala	Ser	Asn	Ser	Asn	Lys	Thr	Trp	Arg	Met	Glu				
465					470					475					480				
Gln	Asn	Gly	Arg	Ala	Thr	Gly	Phe	Leu	Leu	Lys	Glu	Asn	Ile	Arg	Pro				
				485					490					495					
Phe	Gln	Leu	Tyr	Glu	Ile	Ile	Val	Thr	Pro	Leu	Tyr	Gln	Asp	Thr	Met				
			500					505					510						

Gly Pro Ser Gln His Val Tyr Ala Tyr Ser Gln Glu Met Ala Pro Ser  
 515 520 525

His Ala Pro Glu Leu His Leu Lys His Ile Gly Lys Thr Trp Ala Gln  
 530 535 540

Leu Glu Trp Val Pro Glu Pro Pro Glu Leu Gly Lys Ser Pro Leu Thr  
 545 550 555 560

His Tyr Thr Ile Phe Trp Thr Asn Ala Gln Asn Gln Ser Phe Ser Ala  
 565 570 575

Ile Leu Asn Ala Ser Ser Arg Gly Phe Val Leu His Gly Leu Glu Pro  
 580 585 590

Ala Ser Leu Tyr His Ile His Leu Met Ala Ala Ser Gln Ala Gly Ala  
 595 600 605

Thr Asn Ser Thr Val Leu Thr Leu Met Thr Leu Thr Pro Glu Gly Ser  
 610 615 620

Glu Leu His Ile Ile Leu Gly Leu Phe Gly Leu Leu Leu Leu Thr  
 625 630 635 640

Cys Leu Cys Gly Thr Ala Trp Leu Cys Cys Ser Pro Asn Arg Lys Asn  
 645 650 655

Pro Leu Trp Pro Ser Val Pro Asp Pro Ala His Ser Ser Leu Gly Ser  
 660 665 670

Trp Val Pro Thr Ile Met Glu Glu Asp Ala Phe Gln Leu Pro Gly Leu  
 675 680 685

Gly Thr Pro Pro Ile Thr Lys Leu Thr Val Leu Glu Glu Asp Glu Lys  
 690 695 700

Lys Pro Val Pro Trp Glu Ser His Asn Ser Ser Glu Thr Cys Gly Leu  
 705 710 715 720

Pro Thr Leu Val Gln Thr Tyr Val Leu Gln Gly Asp Pro Arg Ala Val  
 725 730 735

Ser Thr Gln Pro Gln Ser Gln Ser Gly Thr Ser Asp Gln Val Leu Tyr  
 740 745 750

Gly Gln Leu Leu Gly Ser Pro Thr Ser Pro Gly Pro Gly His Tyr Leu  
755 760 765

Arg Cys Asp Ser Thr Gln Pro Leu Leu Ala Gly Leu Thr Pro Ser Pro  
770 775 780

Lys Ser Tyr Glu Asn Leu Trp Phe Gln Ala Ser Pro Leu Gly Thr Leu  
785 790 795 800

Val Thr Pro Ala Pro Ser Gln Glu Asp Asp Cys Val Phe Gly Pro Leu  
805 810 815

Leu Asn Phe Pro Leu Leu Gln Gly Ile Arg Val His Gly Met Glu Ala  
820 825 830

Leu Gly Ser Phe  
835

<210> 10  
<211> 7  
<212> PRT  
<213> Homo sapiens

<400> 10

Trp Lys Ser Thr Ser Val Lys  
1 5

<210> 11  
<211> 15  
<212> PRT  
<213> Homo sapiens

<400> 11

Glu Gly Lys Leu Leu Pro Ala Ile Pro Val Leu Ser Ala Leu Lys  
1 5 10 15

<210> 12  
<211> 726  
<212> PRT  
<213> Mus musculus

<400> 12

Met Lys Pro Leu Gly Val Asn Ala Gly Ile Met Trp Thr Leu Ala Leu  
1 5 10 15

Trp Ala Phe Ser Phe Leu Cys Lys Phe Ser Leu Ala Val Leu Pro Thr  
20 25 30

Lys Pro Glu Asn Ile Ser Cys Val Phe Tyr Phe Asp Arg Asn Leu Thr  
 35 40 45  
 Cys Thr Trp Arg Pro Glu Lys Glu Thr Asn Asp Thr Ser Tyr Ile Val  
 50 55 60  
 Thr Leu Thr Tyr Ser Tyr Gly Lys Ser Asn Tyr Ser Asp Asn Ala Thr  
 65 70 75 80  
 Glu Ala Ser Tyr Ser Phe Pro Arg Ser Cys Ala Met Pro Pro Asp Ile  
 85 90 95  
 Cys Ser Val Glu Val Gln Ala Gln Asn Gly Asp Gly Lys Val Lys Ser  
 100 105 110  
 Asp Ile Thr Tyr Trp His Leu Ile Ser Ile Ala Lys Thr Glu Pro Pro  
 115 120 125  
 Ile Ile Leu Ser Val Asn Pro Ile Cys Asn Arg Met Phe Gln Ile Gln  
 130 135 140  
 Trp Lys Pro Arg Glu Lys Thr Arg Gly Phe Pro Leu Val Cys Met Leu  
 145 150 155 160  
 Arg Phe Arg Thr Val Asn Ser Ser Arg Trp Thr Glu Val Asn Phe Glu  
 165 170 175  
 Asn Cys Lys Gln Val Cys Asn Leu Thr Gly Leu Gln Ala Phe Thr Glu  
 180 185 190  
 Tyr Val Leu Ala Leu Arg Phe Arg Phe Asn Asp Ser Arg Tyr Trp Ser  
 195 200 205  
 Lys Trp Ser Lys Glu Glu Thr Arg Val Thr Met Glu Glu Val Pro His  
 210 215 220  
 Val Leu Asp Leu Trp Arg Ile Leu Glu Pro Ala Asp Met Asn Gly Asp  
 225 230 235 240  
 Arg Lys Val Arg Leu Leu Trp Lys Lys Ala Arg Gly Ala Pro Val Leu  
 245 250 255  
 Glu Lys Thr Phe Gly Tyr His Ile Gln Tyr Phe Ala Glu Asn Ser Thr  
 260 265 270



Asn Leu Thr Glu Ile Asn Asn Ile Thr Thr Gln Gln Tyr Glu Leu Leu  
 275 280 285

Leu Met Ser Gln Ala His Ser Val Ser Val Thr Ser Phe Asn Ser Leu  
 290 295 300

Gly Lys Ser Gln Glu Thr Ile Leu Arg Ile Pro Asp Val His Glu Lys  
 305 310 315 320

Thr Phe Gln Tyr Ile Lys Ser Met Gln Ala Tyr Ile Ala Glu Pro Leu  
 325 330 335

Leu Val Val Asn Trp Gln Ser Ser Ile Pro Ala Val Asp Thr Trp Ile  
 340 345 350

Val Glu Trp Leu Pro Glu Ala Ala Met Ser Lys Phe Pro Ala Leu Ser  
 355 360 365

Trp Glu Ser Val Ser Gln Val Thr Asn Trp Thr Ile Glu Gln Asp Lys  
 370 375 380

Leu Lys Pro Phe Thr Cys Tyr Asn Ile Ser Val Tyr Pro Val Leu Gly  
 385 390 395 400

His Arg Val Gly Glu Pro Tyr Ser Ile Gln Ala Tyr Ala Lys Glu Gly  
 405 410 415

Thr Pro Leu Lys Gly Pro Glu Thr Arg Val Glu Asn Ile Gly Leu Arg  
 420 425 430

Thr Ala Thr Ile Thr Trp Lys Glu Ile Pro Lys Ser Ala Arg Asn Gly  
 435 440 445

Phe Ile Asn Asn Tyr Thr Val Phe Tyr Gln Ala Glu Gly Gly Lys Glu  
 450 455 460

Leu Ser Lys Thr Val Asn Ser His Ala Leu Gln Cys Asp Leu Glu Ser  
 465 470 475 480

Leu Thr Arg Arg Thr Ser Tyr Thr Val Trp Val Met Ala Ser Thr Arg  
 485 490 495

Ala Gly Gly Thr Asn Gly Val Arg Ile Asn Phe Lys Thr Leu Ser Ile  
 500 505 510

Ser Val Phe Glu Val Val Leu Leu Thr Ser Leu Val Gly Gly Gly Leu

515					520					525					
Leu	Leu	Leu	Ser	Ile	Lys	Thr	Val	Thr	Phe	Gly	Leu	Arg	Lys	Pro	Asn
530						535					540				
Arg	Leu	Thr	Pro	Leu	Cys	Cys	Pro	Asp	Val	Pro	Asn	Pro	Ala	Glu	Ser
545					550					555					560
Ser	Leu	Ala	Thr	Trp	Leu	Gly	Asp	Gly	Phe	Lys	Lys	Ser	Asn	Met	Lys
				565					570					575	
Glu	Thr	Gly	Asn	Ser	Gly	Asn	Thr	Glu	Asp	Val	Val	Leu	Lys	Pro	Cys
			580					585					590		
Pro	Val	Pro	Ala	Asp	Leu	Ile	Asp	Lys	Leu	Val	Val	Asn	Phe	Glu	Asn
		595					600					605			
Phe	Leu	Glu	Val	Val	Leu	Thr	Glu	Glu	Ala	Gly	Lys	Gly	Gln	Ala	Ser
610						615					620				
Ile	Leu	Gly	Gly	Glu	Ala	Asn	Glu	Tyr	Val	Thr	Ser	Pro	Ser	Arg	Pro
625					630					635					640
Asp	Gly	Pro	Pro	Gly	Lys	Ser	Phe	Lys	Glu	Pro	Ser	Ile	Leu	Thr	Glu
				645					650					655	
Val	Ala	Ser	Glu	Asp	Ser	His	Ser	Thr	Cys	Ser	Arg	Met	Ala	Asp	Glu
			660					665					670		
Ala	Tyr	Ser	Glu	Leu	Ala	Arg	Gln	Pro	Ser	Ser	Ser	Cys	Gln	Ser	Pro
		675					680					685			
Gly	Leu	Ser	Pro	Pro	Arg	Glu	Asp	Gln	Ala	Gln	Asn	Pro	Tyr	Leu	Lys
690						695					700				
Asn	Ser	Val	Thr	Thr	Arg	Glu	Phe	Leu	Val	His	Glu	Asn	Ile	Pro	Glu
705					710					715					720
His	Ser	Lys	Gly	Glu	Val										
				725											

<210> 13  
 <211> 252  
 <212> PRT  
 <213> Homo sapiens

<400> 13

Met	Lys	Leu	Ser	Pro	Gln	Pro	Ser	Cys	Val	Asn	Leu	Gly	Met	Met	Trp	1	5	10	15
Thr	Trp	Ala	Leu	Trp	Met	Leu	Pro	Ser	Leu	Cys	Lys	Phe	Ser	Leu	Ala	20	25	30	
Ala	Leu	Pro	Ala	Lys	Pro	Glu	Asn	Ile	Ser	Cys	Val	Tyr	Tyr	Tyr	Arg	35	40	45	
Lys	Asn	Leu	Thr	Cys	Thr	Trp	Ser	Pro	Gly	Lys	Glu	Thr	Ser	Tyr	Thr	50	55	60	
Gln	Tyr	Thr	Val	Lys	Arg	Thr	Tyr	Ala	Phe	Gly	Glu	Lys	His	Asp	Asn	65	70	75	80
Cys	Thr	Thr	Asn	Ser	Ser	Thr	Ser	Glu	Asn	Arg	Ala	Ser	Cys	Ser	Phe	85	90	95	
Phe	Leu	Pro	Arg	Ile	Thr	Ile	Pro	Asp	Asn	Tyr	Thr	Ile	Glu	Val	Glu	100	105	110	
Ala	Glu	Asn	Gly	Asp	Gly	Val	Ile	Lys	Ser	His	Met	Thr	Tyr	Trp	Arg	115	120	125	
Leu	Glu	Asn	Ile	Ala	Lys	Thr	Glu	Pro	Pro	Lys	Ile	Phe	Arg	Val	Lys	130	135	140	
Pro	Val	Leu	Gly	Ile	Lys	Arg	Met	Ile	Gln	Ile	Glu	Trp	Ile	Lys	Pro	145	150	155	160
Glu	Leu	Ala	Pro	Val	Ser	Ser	Asp	Leu	Lys	Tyr	Thr	Leu	Arg	Phe	Arg	165	170	175	
Thr	Val	Asn	Ser	Thr	Ser	Trp	Met	Glu	Val	Asn	Phe	Ala	Lys	Asn	Arg	180	185	190	
Lys	Asp	Lys	Asn	Gln	Thr	Tyr	Asn	Leu	Thr	Gly	Leu	Gln	Pro	Phe	Thr	195	200	205	
Glu	Tyr	Val	Ile	Ala	Leu	Arg	Cys	Ala	Val	Lys	Glu	Ser	Lys	Phe	Trp	210	215	220	
Ser	Asp	Trp	Ser	Gln	Glu	Lys	Met	Gly	Met	Thr	Glu	Glu	Glu	Gly	Lys	225	230	235	240

Leu Leu Pro Ala Ile Pro Val Leu Ser Thr Leu Val  
 245 250

<210> 14  
 <211> 652  
 <212> PRT  
 <213> Homo sapiens  
 <400> 14

Met Lys Leu Ser Pro Gln Pro Ser Cys Val Asn Leu Gly Met Met Trp  
 1 5 10 15

Thr Trp Ala Leu Trp Met Leu Pro Ser Leu Cys Lys Phe Ser Leu Ala  
 20 25 30

Ala Leu Pro Ala Lys Pro Glu Asn Ile Ser Cys Val Tyr Tyr Tyr Arg  
 35 40 45

Lys Asn Leu Thr Cys Thr Trp Ser Pro Gly Lys Glu Thr Ser Tyr Thr  
 50 55 60

Gln Tyr Thr Val Lys Arg Thr Tyr Ala Phe Gly Glu Lys His Asp Asn  
 65 70 75 80

Cys Thr Thr Asn Ser Ser Thr Ser Glu Asn Arg Ala Ser Cys Ser Phe  
 85 90 95

Phe Leu Pro Arg Ile Thr Ile Pro Asp Asn Tyr Thr Ile Glu Val Glu  
 100 105 110

Ala Glu Asn Gly Asp Gly Val Ile Lys Ser His Met Thr Tyr Trp Arg  
 115 120 125

Leu Glu Asn Ile Ala Lys Thr Glu Pro Pro Lys Ile Phe Arg Val Lys  
 130 135 140

Pro Val Leu Gly Ile Lys Arg Met Ile Gln Ile Glu Trp Ile Lys Pro  
 145 150 155 160

Glu Leu Ala Pro Val Ser Ser Asp Leu Lys Tyr Thr Leu Arg Phe Arg  
 165 170 175

Thr Val Asn Ser Thr Ser Trp Met Glu Val Asn Phe Ala Lys Asn Arg  
 180 185 190

Lys Asp Lys Asn Gln Thr Tyr Asn Leu Thr Gly Leu Gln Pro Phe Thr  
 195 200 205

Glu Tyr Val Ile Ala Leu Arg Cys Ala Val Lys Glu Ser Lys Phe Trp  
 210 215 220  
 Ser Asp Trp Ser Gln Glu Lys Met Gly Met Thr Glu Glu Glu Ala Pro  
 225 230 235 240  
 Cys Gly Leu Glu Leu Trp Arg Val Leu Lys Pro Ala Glu Ala Asp Gly  
 245 250 255  
 Arg Arg Pro Val Arg Leu Leu Trp Lys Lys Ala Arg Gly Ala Pro Val  
 260 265 270  
 Leu Glu Lys Thr Leu Gly Tyr Asn Ile Trp Tyr Tyr Pro Glu Ser Asn  
 275 280 285  
 Thr Asn Leu Thr Glu Thr Met Asn Thr Thr Asn Gln Gln Leu Glu Leu  
 290 295 300  
 His Leu Gly Gly Glu Ser Phe Trp Val Ser Met Ile Ser Tyr Asn Ser  
 305 310 315 320  
 Leu Gly Lys Ser Pro Val Ala Thr Leu Arg Ile Pro Ala Ile Gln Glu  
 325 330 335  
 Lys Ser Phe Gln Cys Ile Glu Val Met Gln Ala Cys Val Ala Glu Asp  
 340 345 350  
 Gln Leu Val Val Lys Trp Gln Ser Ser Ala Leu Asp Val Asn Thr Trp  
 355 360 365  
 Met Ile Glu Trp Phe Pro Asp Val Asp Ser Glu Pro Thr Thr Leu Ser  
 370 375 380  
 Trp Glu Ser Val Ser Gln Ala Thr Asn Trp Thr Ile Gln Gln Asp Lys  
 385 390 395 400  
 Leu Lys Pro Phe Trp Cys Tyr Asn Ile Ser Val Tyr Pro Met Leu His  
 405 410 415  
 Asp Lys Val Gly Glu Pro Tyr Ser Ile Gln Ala Tyr Ala Lys Glu Gly  
 420 425 430  
 Val Pro Ser Glu Gly Pro Glu Thr Lys Val Glu Asn Ile Gly Val Lys  
 435 440 445

Thr Val Thr Ile Thr Trp Lys Glu Ile Pro Lys Ser Glu Arg Lys Gly  
 450 455 460

Ile Ile Cys Asn Tyr Thr Ile Phe Tyr Gln Ala Glu Gly Gly Lys Gly  
 465 470 475 480

Phe Ser Lys Thr Val Asn Ser Ser Ile Leu Gln Tyr Gly Leu Glu Ser  
 485 490 495

Leu Lys Arg Lys Thr Ser Tyr Ile Val Gln Val Met Ala Asn Thr Ser  
 500 505 510

Ala Gly Gly Thr Asn Gly Thr Ser Ile Asn Phe Lys Thr Leu Ser Phe  
 515 520 525

Ser Val Phe Glu Ile Ile Leu Ile Thr Ser Leu Ile Gly Gly Gly Leu  
 530 535 540

Leu Ile Leu Ile Ile Leu Thr Val Ala Tyr Gly Leu Lys Lys Pro Asn  
 545 550 555 560

Lys Leu Thr His Leu Cys Trp Pro Thr Val Pro Asn Pro Ala Glu Ser  
 565 570 575

Ser Ile Ala Thr Trp His Gly Asp Asp Phe Lys Asp Lys Leu Asn Leu  
 580 585 590

Lys Glu Ser Asp Asp Ser Val Asn Thr Glu Asp Arg Ile Leu Lys Pro  
 595 600 605

Cys Ser Thr Pro Ser Asp Lys Leu Val Ile Asp Lys Leu Val Val Asn  
 610 615 620

Phe Gly Asn Val Leu Gln Glu Ile Phe Thr Asp Glu Ala Arg Thr Gly  
 625 630 635 640

Gln Glu Lys Gln Phe Arg Arg Gly Lys Glu Trp Asp  
 645 650

<210> 15  
 <211> 662  
 <212> PRT  
 <213> Homo sapiens

<400> 15

Met Lys Leu Ser Pro Gln Pro Ser Cys Val Asn Leu Gly Met Met Trp

1	5	10	15
Thr Trp Ala Leu Trp Met Leu Pro Ser Leu Cys Lys Phe Ser Leu Ala	20	25	30
Ala Leu Pro Ala Lys Pro Glu Asn Ile Ser Cys Val Tyr Tyr Tyr Arg	35	40	45
Lys Asn Leu Thr Cys Thr Trp Ser Pro Gly Lys Glu Thr Ser Tyr Thr	50	55	60
Gln Tyr Thr Val Lys Arg Thr Tyr Ala Phe Gly Glu Lys His Asp Asn	65	70	75
Cys Thr Thr Asn Ser Ser Thr Ser Glu Asn Arg Ala Ser Cys Ser Phe	85	90	95
Phe Leu Pro Arg Ile Thr Ile Pro Asp Asn Tyr Thr Ile Glu Val Glu	100	105	110
Ala Glu Asn Gly Asp Gly Val Ile Lys Ser His Met Thr Tyr Trp Arg	115	120	125
Leu Glu Asn Ile Ala Lys Thr Glu Pro Pro Lys Ile Phe Arg Val Lys	130	135	140
Pro Val Leu Gly Ile Lys Arg Met Ile Gln Ile Glu Trp Ile Lys Pro	145	150	155
Glu Leu Ala Pro Val Ser Ser Asp Leu Lys Tyr Thr Leu Arg Phe Arg	165	170	175
Thr Val Asn Ser Thr Ser Trp Met Glu Val Asn Phe Ala Lys Asn Arg	180	185	190
Lys Asp Lys Asn Gln Thr Tyr Asn Leu Thr Gly Leu Gln Pro Phe Thr	195	200	205
Glu Tyr Val Ile Ala Leu Arg Cys Ala Val Lys Glu Ser Lys Phe Trp	210	215	220
Ser Asp Trp Ser Gln Glu Lys Met Gly Met Thr Glu Glu Glu Ala Pro	225	230	235
Cys Gly Leu Glu Leu Trp Arg Val Leu Lys Pro Ala Glu Ala Asp Gly	245	250	255

Arg Arg Pro Val Arg Leu Leu Trp Lys Lys Ala Arg Gly Ala Pro Val  
 260 265 270

Leu Glu Lys Thr Leu Gly Tyr Asn Ile Trp Tyr Tyr Pro Glu Ser Asn  
 275 280 285

Thr Asn Leu Thr Glu Thr Met Asn Thr Thr Asn Gln Gln Leu Glu Leu  
 290 295 300

His Leu Gly Gly Glu Ser Phe Trp Val Ser Met Ile Ser Tyr Asn Ser  
 305 310 315 320

Leu Gly Lys Ser Pro Val Ala Thr Leu Arg Ile Pro Ala Ile Gln Glu  
 325 330 335

Lys Ser Phe Gln Cys Ile Glu Val Met Gln Ala Cys Val Ala Glu Asp  
 340 345 350

Gln Leu Val Val Lys Trp Gln Ser Ser Ala Leu Asp Val Asn Thr Trp  
 355 360 365

Met Ile Glu Trp Phe Pro Asp Val Asp Ser Glu Pro Thr Thr Leu Ser  
 370 375 380

Trp Glu Ser Val Ser Gln Ala Thr Asn Trp Thr Ile Gln Gln Asp Lys  
 385 390 395 400

Leu Lys Pro Phe Trp Cys Tyr Asn Ile Ser Val Tyr Pro Met Leu His  
 405 410 415

Asp Lys Val Gly Glu Pro Tyr Ser Ile Gln Ala Tyr Ala Lys Glu Gly  
 420 425 430

Val Pro Ser Glu Gly Pro Glu Thr Lys Val Glu Asn Ile Gly Val Lys  
 435 440 445

Thr Val Thr Ile Thr Trp Lys Glu Ile Pro Lys Ser Glu Arg Lys Gly  
 450 455 460

Ile Ile Cys Asn Tyr Thr Ile Phe Tyr Gln Ala Glu Gly Gly Lys Gly  
 465 470 475 480

Phe Ser Lys Thr Val Asn Ser Ser Ile Leu Gln Tyr Gly Leu Glu Ser  
 485 490 495



Leu Lys Arg Lys Thr Ser Tyr Ile Val Gln Val Met Ala Ser Thr Ser  
500 505 510

Ala Gly Gly Thr Asn Gly Thr Ser Ile Asn Phe Lys Thr Leu Ser Phe  
515 520 525

Ser Val Phe Glu Ile Ile Leu Ile Thr Ser Leu Ile Gly Gly Gly Leu  
530 535 540

Leu Ile Leu Ile Ile Leu Thr Val Ala Tyr Gly Leu Lys Lys Pro Asn  
545 550 555 560

Lys Leu Thr His Leu Cys Trp Pro Thr Val Pro Asn Pro Ala Glu Ser  
565 570 575

Ser Ile Ala Thr Trp His Gly Asp Asp Phe Lys Asp Lys Leu Asn Leu  
580 585 590

Lys Glu Ser Asp Asp Ser Val Asn Thr Glu Asp Arg Ile Leu Lys Pro  
595 600 605

Cys Ser Thr Pro Ser Asp Lys Leu Val Ile Asp Lys Leu Val Val Asn  
610 615 620

Phe Gly Asn Val Leu Gln Glu Ile Phe Thr Asp Glu Ala Arg Thr Gly  
625 630 635 640

Gln Glu Asn Asn Leu Gly Gly Glu Lys Asn Gly Thr Arg Ile Leu Ser  
645 650 655

Ser Cys Pro Thr Ser Ile  
660

<210> 16  
<211> 344  
<212> PRT  
<213> Homo sapiens

<400> 16

Asn Pro Lys Asn Glu Ser Ser Glu Asn Ile Arg Glu Arg Leu Ser Leu  
1 5 10 15

Pro Ser Thr Leu Gln Gln Asn Phe Gly Thr Leu Asn Phe Trp Phe Gln  
20 25 30

Arg Ser His Asn Phe His Asn Leu Thr Thr Glu Glu Gly Pro Ser Thr

35					40					45					
Pro	Ile	Gly	Thr	Leu	Lys	Pro	Gly	Leu	Val	Ile	Lys	Ala	Val	Arg	Lys
50						55					60				
Leu	Leu	Met	Asn	Asp	Ser	Asp	Gln	Gly	Gly	Lys	Leu	Thr	Thr	Gly	Val
65					70					75					80
Phe	Thr	Pro	Gln	Gln	Leu	Ala	Asn	Thr	Thr	Asn	Gln	Gly	Leu	Ser	Arg
				85					90					95	
Cys	Leu	Ser	Arg	Phe	Lys	Lys	Val	Ile	Arg	Ala	Met	Leu	Met	Met	Lys
			100					105					110		
Ile	Lys	Leu	Lys	Arg	Ile	Thr	Asn	Ile	Asn	Cys	Ser	Gly	His	Ile	Trp
		115					120					125			
Val	Glu	Pro	Ala	Thr	Ile	Phe	Lys	Met	Gly	Met	Asn	Ile	Ser	Ile	Tyr
	130					135					140				
Cys	Gln	Ala	Ala	Ile	Lys	Asn	Cys	Gln	Pro	Arg	Lys	Leu	His	Phe	Tyr
145					150					155					160
Lys	Asn	Gly	Ile	Lys	Glu	Arg	Phe	Gln	Ile	Thr	Arg	Ile	Asn	Lys	Thr
				165					170					175	
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Pro	Ser	Gln	Val	Leu	Ala	Gly	Gly	Pro	Leu	Ser	Pro	Asn	Pro	Thr	Pro
225					230					235					240
Gly	Asn	Val	Glu	Asp	Pro	Pro	Asp	Ile	Pro	Asp	Glu	Val	Thr	Cys	Val
				245					250					255	
Ile	Tyr	Glu	Tyr	Ser	Gly	Asn	Met	Thr	Cys	Thr	Trp	Asn	Ala	Gly	Lys
			260					265					270		
Leu	Thr	Tyr	Ile	Asp	Thr	Lys	Tyr	Val	Val	His	Val	Lys	Ser	Leu	Glu
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Thr Asp Ser Leu Gln Gly Gly Lys Lys Tyr Leu Val Trp Val Gln Ala  
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<210> 21
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<212> PRT
<213> Homo sapiens

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<400> 21

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Leu Phe Ser Trp Cys His Gly Gly Ile Thr Asn Ile Asn Cys Ser Gly
          20           25           30

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His Ile Trp Val Glu Pro Ala Thr Ile Phe Lys Met Gly Met Asn Ile
          35           40           45

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Ser Ile Tyr Cys Gln Ala Ala Ile Lys Asn Cys Gln Pro Arg Lys Leu
          50           55           60

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His Phe Tyr Lys Asn Gly Ile Lys Glu Arg Phe Gln Ile Thr Arg Ile  
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Asn Lys Thr Thr Ala Arg Leu Trp Tyr Lys Asn Phe Leu Glu Pro His  
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Ala Ser Met Tyr Cys Thr Ala Glu Cys Pro Lys His Phe Gln Glu Thr  
 100 105 110

Leu Ile Cys Gly Lys Asp Ile Ser Ser Gly Tyr Pro Pro Asp Ile Pro  
 115 120 125

Asp Glu Val Thr Cys Val Ile Tyr Glu Tyr Ser Gly Asn Met Thr Cys  
 130 135 140

Thr Trp Asn Ala Gly Lys Leu Thr Tyr Ile Asp Thr Lys Tyr Val Val  
 145 150 155 160

His Val Lys Ser Leu Glu Thr Glu Glu Glu Gln Gln Tyr Leu Thr Ser  
 165 170 175

Ser Tyr Ile Asn Ile Ser Thr Asp Ser Leu Gln Gly Gly Lys Lys Tyr  
 180 185 190

Leu Val Trp Val Gln Ala Ala Asn Ala Leu Gly Met Glu Glu Ser Lys  
 195 200 205

Gln Leu Gln Ile His Leu Asp Asp Ile Val Ile Pro Ser Ala Ala Val  
 210 215 220

Ile Ser Arg Ala Glu Thr Ile Asn Ala Thr Val Pro Lys Thr Ile Ile  
 225 230 235 240

Tyr Trp Asp Ser Gln Thr Thr Ile Glu Lys Val Ser Cys Glu Met Arg  
 245 250 255

Tyr Lys Ala Thr Thr Asn Gln Thr Trp Asn Val Lys Glu Phe Asp Thr  
 260 265 270

Asn Phe Thr Tyr Val Gln Gln Ser Glu Phe Tyr Leu Glu Pro Asn Ile  
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Lys Tyr Val Phe Gln Val Arg Cys Gln Glu Thr Gly Lys Arg Tyr Trp  
 290 295 300

Gln Pro Trp Ser Ser Leu Phe Phe His Lys Thr Pro Glu Thr Val Pro  
 305 310 315 320

Gln Val Thr Ser Lys Ala Phe Gln His Asp Thr Trp Asn Ser Gly Leu  
 325 330 335

Thr Val Ala Ser Ile Ser Thr Gly His Leu Thr Ser Asp Asn Arg Gly  
 340 345 350

Asp Ile Gly Leu Leu Leu Gly Met Ile Val Phe Ala Val Met Leu Ser  
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Ile Leu Ser Leu Ile Gly Ile Phe Asn Arg Ser Phe Arg Thr Gly Ile  
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Lys Arg Arg Ile Leu Leu Leu Ile Pro Lys Trp Leu Tyr Glu Asp Ile  
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Pro Asn Met Lys Asn Ser Asn Val Val Lys Met Leu Gln Glu Asn Ser  
 405 410 415

Glu Leu Met Asn Asn Asn Ser Ser Glu Gln Val Leu Tyr Val Asp Pro  
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Met Ile Thr Glu Ile Lys Glu Ile Phe Ile Pro Glu His Lys Pro Thr  
 435 440 445

Asp Tyr Lys Lys Glu Asn Thr Gly Pro Leu Glu Thr Arg Asp Tyr Pro  
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Gln Asn Ser Leu Phe Asp Asn Thr Thr Val Val Tyr Ile Pro Asp Leu  
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Asn Thr Gly Tyr Lys Pro Gln Ile Ser Asn Phe Leu Pro Glu Gly Ser  
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His Leu Ser Asn Asn Asn Glu Ile Thr Ser Leu Thr Leu Lys Pro Pro  
 500 505 510

Val Asp Ser Leu Asp Ser Gly Asn Asn Pro Arg Leu Gln Lys His Pro  
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Asn Phe Ala Phe Ser Val Ser Ser Val Asn Ser Leu Ser Asn Thr Ile  
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Phe Leu Gly Glu Leu Ser Leu Ile Leu Asn Gln Gly Glu Cys Ser Ser



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<211> 1698
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<213> Homo sapiens
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<210> 23
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<212> PRT
<213> Homo sapiens

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<400> 23

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Leu Phe Ser Trp Cys His Gly Gly Ile Thr Asn Ile Asn Cys Ser Gly
          20           25           30

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His Ile Trp Val Glu Pro Ala Thr Ile Phe Lys Met Gly Met Asn Ile
          35           40           45

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Ser Ile Tyr Cys Gln Ala Ala Ile Lys Asn Cys Gln Pro Arg Lys Leu
          50           55           60

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His Phe Tyr Lys Asn Gly Ile Lys Glu Arg Phe Gln Ile Thr Arg Ile
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Asn Lys Thr Thr Ala Arg Leu Trp Tyr Lys Asn Phe Leu Glu Pro His
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Ala Ser Met Tyr Cys Thr Ala Glu Cys Pro Lys His Phe Gln Glu Thr
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Leu Ile Cys Gly Lys Asp Ile Ser Ser Gly Tyr Pro Pro Asp Ile Pro  
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Asp Glu Val Thr Cys Val Ile Tyr Glu Tyr Ser Gly Asn Met Thr Cys  
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Thr Trp Asn Ala Gly Lys Leu Thr Tyr Ile Asp Thr Lys Tyr Val Val  
 145 150 155 160

His Val Lys Ser Leu Glu Thr Glu Glu Glu Gln Gln Tyr Leu Thr Ser  
 165 170 175

Ser Tyr Ile Asn Ile Ser Thr Asp Ser Leu Gln Gly Gly Lys Lys Tyr  
 180 185 190

Leu Val Trp Val Gln Ala Ala Asn Ala Leu Gly Met Glu Glu Ser Lys  
 195 200 205

Gln Leu Gln Ile His Leu Asp Asp Ile Val Ile Pro Ser Ala Ala Val  
 210 215 220

Ile Ser Arg Ala Glu Thr Ile Asn Ala Thr Val Pro Lys Thr Ile Ile  
 225 230 235 240

Tyr Trp Asp Ser Gln Thr Thr Ile Glu Lys Val Ser Cys Glu Met Arg  
 245 250 255

Tyr Lys Ala Thr Thr Asn Gln Thr Trp Asn Val Lys Glu Phe Asp Thr  
 260 265 270

Asn Phe Thr Tyr Val Gln Gln Ser Glu Phe Tyr Leu Glu Pro Asn Ile  
 275 280 285

Lys Tyr Val Phe Gln Val Arg Cys Gln Glu Thr Gly Lys Arg Tyr Trp  
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Gln Pro Trp Ser Ser Leu Phe Phe His Lys Thr Pro Glu Thr Gly Ile  
 305 310 315 320

Lys Arg Arg Ile Leu Leu Leu Ile Pro Lys Trp Leu Tyr Glu Asp Ile  
 325 330 335

Pro Asn Met Lys Asn Ser Asn Val Val Lys Met Leu Gln Glu Asn Ser  
 340 345 350

Glu Leu Met Asn Asn Asn Ser Ser Glu Gln Val Leu Tyr Val Asp Pro  
 355 360 365

Met Ile Thr Glu Ile Lys Glu Ile Phe Ile Pro Glu His Lys Pro Thr  
 370 375 380

Asp Tyr Lys Lys Glu Asn Thr Gly Pro Leu Glu Thr Arg Asp Tyr Pro  
 385 390 395 400

Gln Asn Ser Leu Phe Asp Asn Thr Thr Val Val Tyr Ile Pro Asp Leu  
 405 410 415

Asn Thr Gly Tyr Lys Pro Gln Ile Ser Asn Phe Leu Pro Glu Gly Ser  
 420 425 430

His Leu Ser Asn Asn Asn Glu Ile Thr Ser Leu Thr Leu Lys Pro Pro  
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Val Asp Ser Leu Asp Ser Gly Asn Asn Pro Arg Leu Gln Lys His Pro  
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Asn Phe Ala Phe Ser Val Ser Ser Val Asn Ser Leu Ser Asn Thr Ile  
 465 470 475 480

Phe Leu Gly Glu Leu Ser Leu Ile Leu Asn Gln Gly Glu Cys Ser Ser  
 485 490 495

Pro Asp Ile Gln Asn Ser Val Glu Glu Glu Thr Thr Met Leu Leu Glu  
 500 505 510

Asn Asp Ser Pro Ser Glu Thr Ile Pro Glu Gln Thr Leu Leu Pro Asp  
 515 520 525

Glu Phe Val Ser Cys Leu Gly Ile Val Asn Glu Glu Leu Pro Ser Ile  
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Ser Leu Leu Glu Lys  
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<210> 24  
 <211> 1071  
 <212> DNA  
 <213> Homo sapiens

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<210> 25
<211> 356
<212> PRT
<213> Homo sapiens

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Leu Phe Ser Trp Cys His Gly Gly Ile Thr Asn Ile Asn Cys Ser Gly
          20           25           30

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His Ile Trp Val Glu Pro Ala Thr Ile Phe Lys Met Gly Met Asn Ile
          35           40           45

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Ser Ile Tyr Cys Gln Ala Ala Ile Lys Asn Cys Gln Pro Arg Lys Leu
          50           55           60

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His Phe Tyr Lys Asn Gly Ile Lys Glu Arg Phe Gln Ile Thr Arg Ile  
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 Ala Ser Met Tyr Cys Thr Ala Glu Cys Pro Lys His Phe Gln Glu Thr  
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 Leu Ile Cys Gly Lys Asp Ile Ser Ser Gly Tyr Pro Pro Asp Ile Pro  
 115 120 125  
 Asp Glu Val Thr Cys Val Ile Tyr Glu Tyr Ser Gly Asn Met Thr Cys  
 130 135 140  
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98101 (US).
- (21) International Application Number: PCT/US01/31634
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GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC,  
LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW,  
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patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE,  
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CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD,  
TG).
- (71) Applicant (*for all designated States except US*): **IM-  
MUNEX CORPORATION** [US/US]; Law Department,  
51 University Street, Seattle, WA 98101 (US).
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- Published:  
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- (88) Date of publication of the international search report:  
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ning of each regular issue of the PCT Gazette.*

(54) Title: HEMATOPOIETIN RECEPTORS HPR1 AND HPR2

(57) Abstract: This invention relates to human and murine HPR1 and human and murine HPR2 polypeptides, new members of the hematopoietin receptor polypeptide family; to methods of making such HPR1 and HPR2 polypeptides; to non-human mammals in which the endogenous genomic sequences encoding HPR1 and/or HPR2 polypeptides have been partially or completely inactivated; to methods of using HPR1 or HPR2 polypeptides to identify compounds that alter HPR1 or HPR2 polypeptide activities; and to methods of preparing medicaments for and/or treating conditions associated with hematopoietin receptor function.



WO 02/029060 A3

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 01/31634

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 C12N15/12 C07K14/705 C07K14/715

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C07K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

WPI Data, PAJ, EPO-Internal, MEDLINE, CHEM ABS Data, BIOSIS, SEQUENCE SEARCH, EMB

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 98 31811 A (DONALDSON DEBRA D ;GENETICS INST (US); COLLINS MARY (US); NEBEN TA) 23 July 1998 (1998-07-23) the whole document	1,5-7, 12-35
Y	LARSEN A ET AL: "EXPRESSION CLONING OF A HUMAN GRANULOCYTE COLONY-STIMULATING FACTORRECEPTOR: A STRUCTURAL MOSAIC OF HEMATOPOIETIN RECEPTOR, IMMUNOGLOBULIN, AND FIBRONECTIN DOMAINS" JOURNAL OF EXPERIMENTAL MEDICINE, TOKYO, JP, vol. 172, 1 December 1990 (1990-12-01), pages 1559-1570, XP000611514 ISSN: 0022-1007 the whole document	1,5-7, 12-35

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

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- "O" document referring to an oral disclosure, use, exhibition or other means
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- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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- "&" document member of the same patent family

Date of the actual completion of the international search

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Authorized officer

Armandola, E



## INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 01/31634

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,Y	<p>DATABASE EMBL [Online]            SEQ. ID. NO: 17,            26 March 2001 (2001-03-26)            MAEDA M. AND YAGUCHI N.: "Human            haematopoietin receptor protein NR10.3"            Database accession no. AAB51244            XP002209359            the whole document</p>	1,5-7, 12-35
P,X	<p>-&amp; WO 00 75314 A (CHUGAI RES INST FOR            MOLECULAR ;MAEDA MASATSUGU (JP); YAGUCHI            NORIK) 14 December 2000 (2000-12-14)            ---</p>	1,5-7, 12-35
E	<p>WO 02 00721 A (ZYMOGENETICS INC)            3 January 2002 (2002-01-03)            SEQ. ID. NO: 1 and SEQ. ID. NO: 46            ---</p>	1,5-7, 12-35
L	<p>DATABASE EMBL [Online]            Sequence 1 from patent W00200721,            15 February 2002 (2002-02-15)            SPRECHER C.A. ET AL.: "Cytokine receptor            zcytor17"            Database accession no. AX365149            XP002209360            the whole document</p>	
L	<p>-&amp; DATABASE EMBL [Online]            Human zcytor17 protein sequence            SEQ.ID.NO:46, 1 May 2002 (2002-05-01)            SPRECHER C.A. ET AL.: "Isolated            polynucleotide encoding a cytokine            receptor zcytor17."            Database accession no. AAB05730            XP002209361            L document cited to provide information on            the relevant sequence disclosed in            W00200721            the whole document</p>	
E	<p>WO 01 93983 A (STEPHAN JEAN PHILIPPE F            ;BAKER KEVIN P (US); DESNOYERS LUC (US);            G) 13 December 2001 (2001-12-13)            SEQ. ID. NO: 91 and NO: 92            ---</p>	1,5-7, 12-35
	<p>---            -/--</p>	

## INTERNATIONAL SEARCH REPORT

International Application No

PC1/05 01/31634

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
L	<p>DATABASE EMBL [Online] Sequence 91 from patent W00193983, 13 February 2002 (2002-02-13) BAKER K.P. ET AL.: "Secreted transmembrane polypeptides and nucleic acids encoding the same." Database accession no. AX358838 XP002209362 the whole document</p>	
L	<p>-&amp; DATABASE EMBL [Online] Sequence 92 from Patent W00193983, 13 February 2002 (2002-02-13) BAKER K.P. ET AL.: "Secreted and transmembrane polypeptides and nucleic acids encoding the same" Database accession no. AX358839 XP002209363 L document cited to provide information on the relevant sequence disclosed in W00193983 the whole document -----</p>	

# INTERNATIONAL SEARCH REPORT

Int'l application No.  
PCT/US 01/31634

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☒ Claims Nos.: 28, 30-35  
because they relate to subject matter not required to be searched by this Authority, namely:  
Although claims 28 and 30-35 are directed to a method of treatment of the human/animal body, the search has been carried out and based on the alleged effects of the compound/composition.
2. ☒ Claims Nos.: 5, 12-15, 18, 27-30, 32-35  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:  
see FURTHER INFORMATION sheet PCT/ISA/210
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1, 5, 12-35 (partially), 6, 7 (completely)

### Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.  
☐ No protest accompanied the payment of additional search fees.

## FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1, 5, 12-35 (partially), 6,7 (completely)

An isolated polypeptide HPR1 comprising the amino acid sequence of SEQ. ID. NO: 4, subsequences thereof, fusions of subsequences of SEQ. ID. NO: 4, isolated polynucleotides encoding the polypeptides or comprising the nucleotide sequences SEQ. ID. NO: 3, SEQ. ID. NO: 5 and subsequences thereof, expression vectors and host cells containing these sequences, processes for producing the polypeptides, antibodies binding to the polypeptides, methods for identifying modulators, methods of treatment utilizing the polypeptides.

2. Claims: 1,5,12-35 (all partially)

HPR1 amino acid sequences comprising fragments of SEQ. ID. NO: 4 fused to fragments of SEQ. ID. NO: 1, isolated polynucleotides encoding the polypeptides, expression vectors and host cells containing these sequences, processes for producing the polypeptides, antibodies binding to the polypeptides, methods for identifying modulators, methods of treatment utilizing the polypeptides.

3. Claims: 1,5,12-35 (all partially)

HPR1 amino acid sequences comprising fragments of SEQ. ID. NO: 4 fused to fragments of SEQ. ID. NO: 2, isolated polynucleotides encoding the polypeptides, expression vectors and host cells containing these sequences, processes for producing the polypeptides, antibodies binding to the polypeptides, methods for identifying modulators, methods of treatment utilizing the polypeptides.

4. Claims: 1,5,12-35 (all partially)

HPR1 amino acid sequences comprising fragments of SEQ. ID. NO: 4 fused to fragments of SEQ. ID. NO: 10, isolated polynucleotides encoding the polypeptides, expression vectors and host cells containing these sequences, processes for producing the polypeptides, antibodies binding to the polypeptides, methods for identifying modulators, methods of treatment utilizing the polypeptides.

5. Claims: 1,5,12-35 (all partially)

HPR1 amino acid sequences comprising fragments of SEQ. ID. NO: 4 fused to fragments of SEQ. ID. NO: 11, isolated polynucleotides encoding the polypeptides, expression

## FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

vectors and host cells containing these sequences, processes for producing the polypeptides, antibodies binding to the polypeptides, methods for identifying modulators, methods of treatment utilizing the polypeptides.

6. Claims: 2 and 8 (completely), 5 and 12-35 (partially)

An isolated polypeptide HPR1 comprising the amino acid sequence of SEQ. ID. NO: 12, subsequences thereof, fusions of subsequences of SEQ. ID. NO: 12, isolated polynucleotides encoding the polypeptides or comprising the nucleotide sequence SEQ. ID. NO: 28, expression vectors and host cells containing these sequences, processes for producing the polypeptides, antibodies binding to the polypeptides, methods for identifying modulators, methods of treatment utilizing the polypeptides.

7. Claims: 3, 5,9, 12-35 (all partially)

An isolated polypeptide HPR2 comprising the amino acid sequence SEQ. ID. NO: 23, subsequences thereof, isolated polynucleotides encoding the polypeptides or comprising the nucleotide sequence SEQ. ID. NO: 22, expression vectors and host cells containing these sequences, processes for producing the polypeptides, antibodies binding to the polypeptides, methods for identifying modulators, methods of treatment utilizing the polypeptides.

8. Claims: 3, 5,9, 12-35 (all partially)

An isolated polypeptide HPR2 comprising the amino acid sequence SEQ. ID. NO: 25, subsequences thereof, isolated polynucleotides encoding the polypeptides or comprising the nucleotide sequence SEQ. ID. NO: 24, expression vectors and host cells containing these sequences, processes for producing the polypeptides, antibodies binding to the polypeptides, methods for identifying modulators, methods of treatment utilizing the polypeptides.

9. Claims: 3, 5,12-35 (all partially)

HPR2 amino acid sequences comprising fragments of SEQ. ID. NO: 23 fused to SEQ. ID. NO: 16 or to fragments of SEQ. ID. NO: 16 or to SEQ. ID. NO: 17 or to SEQ. ID. NO: 18, isolated polynucleotides encoding the polypeptides, expression vectors and host cells containing these sequences, processes for producing the polypeptides, antibodies binding to the polypeptides, methods for identifying modulators, methods of treatment utilizing the polypeptides.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

10. Claims: 4, 11 (completely), 5 and 12-35 (partially)

An isolated polypeptide HPR2 comprising the amino acid sequence SEQ. ID. NO: 27, subsequences thereof, isolated polynucleotides encoding the polypeptides or comprising the nucleotide sequence SEQ. ID. NO: 29, expression vectors and host cells containing these sequences, processes for producing the polypeptides, antibodies binding to the polypeptides, methods for identifying modulators, methods of treatment utilizing the polypeptides.

11. Claims: 5, 9 and 12-35 (all partially)

Polynucleotide sequences comprising SEQ. ID. NO: 19 or SEQ. ID. NO: 20, isolated polynucleotides encoding the polypeptides, expression vectors and host cells containing these sequences, processes for producing the polypeptides, antibodies binding to the polypeptides, methods for identifying modulators, methods of treatment utilizing the polypeptides.

## FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box I.2

Claims Nos.: 5,12-15,18, 27-30, 32-35

Present claims 5,12-15,18, 27-30, 32-35 relate to an extremely large number of possible compounds/products. Support within the meaning of Article 6 PCT and/or disclosure within the meaning of Article 5 PCT is to be found, however, for only a very small proportion of the compounds/products. In the present case, the claims so lack support, and the application so lacks disclosure, that a meaningful search over the whole of the claimed scope is impossible. Consequently, the search has been carried out for those parts of the claims which appear to be supported and disclosed, namely those parts relating to the DNAs or proteins for which a sequence listing has been provided and to antibodies recognizing the claimed proteins.

The applicant's attention is drawn to the fact that claims, or parts of claims, relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure.

## INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 01/31634

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 01/31634

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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

(54) Title: HEMATOPOIETIN RECEPTORS HPR1 AND HPR2

(57) Abstract: This invention relates to human and murine HPR1 and human and murine HPR2 polypeptides, new members of the hematopoietin receptor polypeptide family; to methods of making such HPR1 and HPR2 polypeptides; to non-human mammals in which the endogenous genomic sequences encoding HPR1 and/or HPR2 polypeptides have been partially or completely inactivated; to methods of using HPR1 or HPR2 polypeptides to identify compounds that alter HPR1 or HPR2 polypeptide activities; and to methods of preparing medicaments for and/or treating conditions associated with hematopoietin receptor function.



WO 02/029060 A3

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**HEMATOPOIETIN RECEPTORS HPR1 AND HPR2**

This application claims the benefit under 35 U.S.C. 119(e) of U.S. provisional applications Serial No. 60/238,706, filed 06 October 2000; Serial No. 60/240,476, filed 13 October 2000; and Serial No. 60/270,282, filed 20 February 2001; all of which are incorporated by reference herein.

10

**FIELD OF THE INVENTION**

This invention relates to new human and murine hematopoietin receptor polypeptides HPR1 and HPR2, and to methods of making and using HPR1 and HPR2 polypeptides.

**BACKGROUND OF THE INVENTION**

15 The hematopoietin receptor polypeptides are a related group of Type I membrane protein receptors, and in some cases soluble forms of those receptors; this family of polypeptides has variously been called the cytokine receptor family or the hematopoietin receptor family. There are other families of receptors that bind cytokines or growth factors, such as the IL-1 receptor family, the TNF receptor family, and the EGF receptor family, but the hematopoietin receptor family is considered to be a distinct group or family of receptors based on certain characteristic structural features or motifs that are  
20 shared by members of this family. Some of the members of the hematopoietin receptor family are gp130, the granulocyte colony-stimulating factor receptor (GCSFR), leukemia inhibitory factor receptor (LIF-R), the alpha chains and the common beta chain of the IL-3 and IL-5 receptors, etc.; the hematopoietin receptor family contains more than 20 different polypeptides.

Common structural features of the hematopoietin receptor family of polypeptides include at  
25 least one extracellular cytokine receptor domain, which usually contains four cysteines and a WSXWS motif (where W is tryptophan, S is serine, and X indicates any amino acid), and, in most members of the family, a transmembrane and a cytoplasmic domain. The extracellular cytokine receptor domain is involved in ligand-binding activity, and the intracellular domain of a 'signaling' subfamily of hematopoietin receptors has a signal transduction function, transmitting the signal generated by ligand  
30 binding to a signal transduction pathway that results in the expression of genes involved in cell proliferation, differentiation, and/or activation. These activities of the hematopoietin receptor polypeptide family are mediated through interactions with cytokine ligands and other ligand-binding receptor molecules, with ligand binding to the cytokine receptor domain of hematopoietin receptor polypeptides and facilitating homo- or heterotypic interactions between receptor polypeptides, bringing  
35 the cytoplasmic domains of receptors into proximity with each other. Many of the cytokine ligands (such as IL-2, IL-6, or ciliary neurotrophic factor or CNTF, for example) interact with more than one type of heteromeric hematopoietin receptor complex, often with differing affinities, and "common" hematopoietin receptor polypeptides such as gp130 are involved in several different heteromeric receptor complexes that bind a variety of ligands. Because of their ligand-binding and intracellular  
40 signaling activities, hematopoietin receptor polypeptides are associated with a wide variety of conditions involving cytokine-influenced cell proliferation, differentiation, or activation. For example, interaction of the gp130 hematopoietin receptor polypeptide with its binding partners is involved in the

5 normal upregulation of cardiac myocyte proliferation ("hypertrophy") in response to biomechanical stress on the heart, as lack of gp130 leads to heart failure under those conditions (Hirota *et al.*, 1999, *Cell* 97(2): 189-198). Hematopoietin receptors are also involved in the activation or stimulation of cells in response to environmental factors, for example the activation of hepatocytes in the acute-phase inflammatory response to injury (Taga and Kishimoto, 1992, *Crit Rev Immunol.* 11(5): 265-280; Neben and Turner, 1993, *Stem Cells* 11 Suppl 2: 156-162). Hematopoietin receptor family polypeptides generally are constitutively expressed in many different cell types throughout development, but the expression levels of hematopoietin receptor polypeptides may be up- or downregulated in response to stimuli, and some members of the family exhibit more restricted patterns of expression in particular tissues. Characteristics and activities of the hematopoietin receptor polypeptide family are described further in the following references, which are incorporated by reference herein: Drachman and Kaushansky, 1995, *Curr Opin Hematol.* 2(1): 22-28; Ihle, 1995, *Nature* 377(6550): 591-594; Taga and Kishimoto, 1995, *Curr Opin Immunol.* 7(1): 17-23; Ihle *et al.*, 1995, *Annu Rev Immunol.* 13: 369-398; Theze, 1994, *Eur Cytokine Netw.* 5(4): 353-368; Ihle *et al.*, 1994, *Trends Biochem Sci.* 19(5): 222-227; Cosman, 1993, *Cytokine* 5(2): 95-106; and Onishi *et al.*, 1998, *Int Rev Immunol.* 16(5-6): 617-634.

20 In order to develop more effective treatments for disorders such as neurological, cardiac, hematopoietic, immunological, hepatic, and pulmonary conditions and diseases involving cell proliferation, differentiation, or activation, including neoplastic transformation or proliferation of virus-infected or cancerous cells, information is needed about previously unidentified members of the hematopoietin receptor polypeptide family.

## 25 SUMMARY OF THE INVENTION

The present invention is based upon the discovery of new human hematopoietin receptor family members, HPR1 and HPR2.

The invention provides an isolated polypeptide consisting of, consisting essentially of, or more preferably, comprising an amino acid sequence selected from the group consisting of:

- 30 (a) the amino acid sequence of SEQ ID NO:4;
- (b) amino acids 56 through 77 of SEQ ID NO:1;
- (c) an amino acid sequence selected from the group consisting of: amino acids 1 through 55 of SEQ ID NO:1; amino acids 5 through 40 of SEQ ID NO:2; amino acids 1 through 32 of SEQ ID NO:4; amino acids 1 through 241 of SEQ ID NO:4; amino acids 1 through 525 of SEQ ID NO:4; amino acids 20 through 32 of SEQ ID NO:4; amino acids 33 through 134 of SEQ ID NO:4; amino acids Xaa1 through Xaa2 of SEQ ID NO:4, wherein Xaa1 is selected from the group consisting of amino acids 33 through 43 of SEQ ID NO:4 and Xaa2 is selected from the group consisting of amino acids 228 through 241 of SEQ ID NO:4; amino acids 33 through 238 of SEQ ID NO:4; amino acids 33 through 241 of SEQ ID NO:4; amino acids 33 through 525 of SEQ ID NO:4; amino acids 33 through 745 of SEQ ID NO:4; amino acids 44 through 94 of SEQ ID NO:4; amino acids 139 through 241 of SEQ ID NO:4; amino acids 242 through 326 of SEQ ID NO:4; amino acids 242 through 514 of SEQ ID NO:4; amino acids 337 through 419 of SEQ ID NO:4;

- 5 amino acids 433 through 514 of SEQ ID NO:4; amino acids 526 through 556 of SEQ ID NO:4; amino acids 533 through 552 of SEQ ID NO:4; amino acids 553 through 745 of SEQ ID NO:4; amino acids 557 through 745 of SEQ ID NO:4; amino acids 563 through 573 of SEQ ID NO:4; amino acids 563 through 641 of SEQ ID NO:4; amino acids 567 through 581 of SEQ ID NO:4; amino acids 588 through 639 of SEQ ID NO:4; and amino acids 631 through 641 of SEQ ID NO:4;
- 10 (d) fragments of the amino acid sequences of any of (a)-(c) comprising at least 20 contiguous amino acids;
- (e) fragments of the amino acid sequences of any of (a)-(c) comprising at least 30 contiguous amino acids;
- 15 (f) fragments of the amino acid sequences of any of (a)-(c) having HPR1 polypeptide activity;
- (g) fragments of the amino acid sequences of any of (a)-(c) comprising cytokine receptor domain amino acid sequences;
- (h) an allelic variant of any of (a)-(c);
- 20 (i) amino acid sequences comprising at least 20 amino acids and sharing amino acid identity with the amino acid sequences of any of (a)-(h), wherein the percent amino acid identity is selected from the group consisting of: at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, at least 97.5%, at least 99%, and at least 99.5%;
- (j) an amino acid sequence of any of (a)-(i) wherein the polypeptide comprising said amino acid sequence also comprises an amino acid sequence selected from the group consisting of SEQ ID NO:10, SEQ ID NO:11, amino acids 652 through 745 of SEQ ID NO:4, a fragment of the sequence of amino acids 652 through 745 of SEQ ID NO:4 comprising at least 20 contiguous amino acids; a fragment of the sequence of amino acids 652 through 745 of SEQ ID NO:4 comprising at least 30 contiguous amino acids; a fragment of the sequence of amino acids 652 through 745 of SEQ ID NO:4 that is at least 25% of the length of the sequence of amino acids 652 through 745 of SEQ ID NO:4; a fragment of the sequence of amino acids 652 through 745 of SEQ ID NO:4 that is at least 50% of the length of the sequence of amino acids 652 through 745 of SEQ ID NO:4; and a fragment of the sequence of amino acids 652 through 745 of SEQ ID NO:4 comprising at least one tyrosine residue;
- 25 (k) an amino acid sequence of any of (a)-(j) wherein the polypeptide comprising said amino acid sequence does not comprise an amino acid sequence selected from the group consisting of amino acids 239 through 252 of SEQ ID NO:13; amino acids 643 through 652 of SEQ ID NO:14; and amino acids 652 through 662 of SEQ ID NO:15;
- 30 (l) an amino acid sequence of (i)-(k), wherein a polypeptide comprising said amino acid sequence of (i)-(k) binds to an antibody that also binds to a polypeptide comprising an amino acid sequence of any of (a)-(h); and
- 40 (m) an amino acid sequence of (i)-(l) having HPR1 polypeptide activity.

- 5 Preferably, such polypeptides are isolated HPR1 polypeptides or isolated polypeptides having HPR1 polypeptide activity.

Other aspects of the invention are isolated nucleic acids encoding polypeptides of the invention, with a preferred embodiment being an isolated nucleic acid consisting of, consisting essentially of, or more preferably, comprising a nucleotide sequence selected from the group consisting of:

- 10 (a) SEQ ID NO:3;  
 (b) SEQ ID NO:5;  
 (c) nucleotides 132 through 2366 of SEQ ID NO:3; and  
 (d) allelic variants of (a)-(c).

- 15 An additional preferred embodiment of the invention is an isolated nucleic acid consisting of, consisting essentially of, or more preferably, comprising a nucleotide sequence selected from the group consisting of nucleotides 1 through 137 of SEQ ID NO:3, nucleotides 138 through 228 of SEQ ID NO:3, nucleotides 229 through 346 of SEQ ID NO:3, nucleotides 347 through 528 of SEQ ID NO:3, nucleotides 529 through 680 of SEQ ID NO:3, nucleotides 681 through 846 of SEQ ID NO:3, nucleotides 847 through 926 of SEQ ID NO:3, nucleotides 927 through 1143 of SEQ ID NO:3,  
 20 nucleotides 1144 through 1326 of SEQ ID NO:3, nucleotides 1327 through 1428 of SEQ ID NO:3, nucleotides 1429 through 1575 of SEQ ID NO:3, nucleotides 1576 through 1716 of SEQ ID NO:3, nucleotides 1717 through 1810 of SEQ ID NO:3, nucleotides 1811 through 1892 of SEQ ID NO:3, and nucleotides 1893 through 2480 of SEQ ID NO:3.

- 25 The invention provides an isolated polypeptide consisting of, consisting essentially of, or more preferably, comprising an amino acid sequence selected from the group consisting of:

- (a) the amino acid sequence of SEQ ID NO:21;  
 (b) an amino acid sequence selected from the group consisting of: amino acids 1 through 177 of SEQ ID NO:16; amino acids 216 through 245 of SEQ ID NO:16; SEQ ID NO:17; SEQ ID NO:18; and amino acids 349 through 356 of SEQ ID NO:23;  
 30 (c) an amino acid sequence selected from the group consisting of: amino acids 1 through 23 of SEQ ID NO:21; amino acids 1 through 124 of SEQ ID NO:21; amino acids 1 through 318 of SEQ ID NO:21; amino acids 1 through 331 of SEQ ID NO:21; amino acids 1 through 355 of SEQ ID NO:21; amino acids Xaa1 through Xaa2 of SEQ ID NO:21, wherein Xaa1 is selected from the group consisting of amino acids 24 through 30 of SEQ ID NO:21 and Xaa2 is selected from the group consisting of amino acids 115 through 124 of SEQ ID NO:21; amino acids 24 through 124 of SEQ ID NO:21; amino acids 24 through 331 of SEQ ID NO:21; amino acids 24 through 355 of SEQ ID NO:21; amino acids Xaa3 through Xaa4 of SEQ ID NO:21, wherein Xaa3 is selected from the group consisting of amino acids 125 through 133 of SEQ ID NO:21 and Xaa4 is selected from the group consisting of amino acids 309 through 331 of SEQ ID NO:21; amino acids 125 through  
 35 219 of SEQ ID NO:21; amino acids 125 through 331 of SEQ ID NO:21; amino acids 133 through 309 of SEQ ID NO:21; amino acids 224 through 320 of SEQ ID NO:21; amino acids 224 through 331 of SEQ ID NO:21; amino acids 319 through 565 of SEQ ID NO:21; amino acids Xaa5 through  
 40

- 5 Xaa6 of SEQ ID NO:21, wherein Xaa5 is selected from the group consisting of amino acids 376 through 393 of SEQ ID NO:21 and Xaa6 is selected from the group consisting of amino acids 618 through 629 of SEQ ID NO:21; amino acids 376 through 629 of SEQ ID NO:21; amino acids 393 through 440 of SEQ ID NO:21; amino acids 393 through 618 of SEQ ID NO:21; and amino acids 397 through 611 of SEQ ID NO:21;
- 10 (d) fragments of the amino acid sequences of any of (a)-(c) comprising at least 20 contiguous amino acids;
- (e) fragments of the amino acid sequences of any of (a)-(c) comprising at least 30 contiguous amino acids;
- (f) fragments of the amino acid sequences of any of (a)-(c) having HPR2 polypeptide activity;
- 15 (g) fragments of the amino acid sequences of any of (a)-(c) comprising cytokine receptor domain amino acid sequences;
- (h) an allelic variant of any of (a)-(c);
- (i) amino acid sequences comprising at least 20 amino acids and sharing amino acid identity with the amino acid sequences of any of (a)-(h), wherein the percent amino acid identity is selected from the group consisting of: at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, at least 97.5%, at least 99%, and at least 99.5%;
- 20 (j) an amino acid sequence of any of (a)-(i) wherein the polypeptide comprising said amino acid sequence also comprises an amino acid sequence selected from the group consisting of:
- 25 amino acids 1 through 177 of SEQ ID NO:16; amino acids 216 through 245 of SEQ ID NO:16; SEQ ID NO:17; SEQ ID NO:18; amino acids 349 through 356 of SEQ ID NO:23; amino acids 319 through 565 of SEQ ID NO:21; amino acids Xaa5 through Xaa6 of SEQ ID NO:21, wherein Xaa5 is selected from the group consisting of amino acids 376 through 393 of SEQ ID NO:21 and Xaa6 is selected from the group consisting of amino acids 618 through 629 of SEQ ID NO:21; amino acids 376 through 629 of SEQ ID NO:21; amino acids 393 through 440 of SEQ ID NO:21; amino acids 393 through 618 of SEQ ID NO:21; amino acids 397 through 611 of SEQ ID NO:21; amino acids 381 through 629 of SEQ ID NO:21; a fragment of the sequence of amino acids 381 through 629 of SEQ ID NO:21 comprising at least 20 contiguous amino acids; a fragment of the sequence of amino acids 381 through 629 of SEQ ID NO:21 comprising at least 30 contiguous amino acids; a fragment of the sequence of amino acids 381 through 629 of SEQ ID NO:21 that is at least 25% of the length of the sequence of amino acids 381 through 629 of SEQ ID NO:21; a fragment of the sequence of amino acids 381 through 629 of SEQ ID NO:21 that is at least 50% of the length of the sequence of amino acids 381 through 629 of SEQ ID NO:21; a fragment of the sequence of amino acids 381 through 629 of SEQ ID NO:21 comprising at least one of the following: an HPR2 Box 1 motif, an HPR2 Box 2 motif, and an HPR2 Box 3 motif; and a fragment of the sequence of amino acids 381 through 629 of SEQ ID NO:21 comprising at least one tyrosine residue;
- 30
- 35
- 40

- 5 (k) an amino acid sequence of any of (a)-(j) wherein the polypeptide comprising said amino acid sequence does not comprise amino acids 381 through 384 of SEQ ID NO:26;
- (l) an amino acid sequence of (i)-(k), wherein a polypeptide comprising said amino acid sequence of (i)-(k) binds to an antibody that also binds to a polypeptide comprising an amino acid sequence of any of (a)-(h); and
- 10 (m) an amino acid sequence of (i)-(l) having HPR2 polypeptide activity.

Preferably, such polypeptides are isolated HPR2 polypeptides or isolated polypeptides having HPR2 polypeptide activity.

Other aspects of the invention are isolated nucleic acids encoding polypeptides of the invention, with a preferred embodiment being an isolated nucleic acid consisting of, consisting essentially of, or more preferably, comprising a nucleotide sequence selected from the group consisting of:

- 15 (a) SEQ ID NO:19;
- (b) SEQ ID NO:20;
- (c) SEQ ID NO:22;
- (d) SEQ ID NO:24; and
- 20 (d) allelic variants of (a)-(d).

An additional preferred embodiment of the invention is an isolated nucleic acid consisting of, consisting essentially of, or more preferably, comprising a nucleotide sequence selected from the group consisting of nucleotides 107 through 175 of SEQ ID NO:19, nucleotides 107 through 478 of SEQ ID NO:19, nucleotides 107 through 1060 of SEQ ID NO:19, nucleotides 107 through 1099 of SEQ ID NO:19, nucleotides 107 through 1171 of SEQ ID NO:19, nucleotides 176 through 478 of SEQ ID NO:19, nucleotides 176 through 1099 of SEQ ID NO:19, nucleotides 176 through 1171 of SEQ ID NO:19, nucleotides 479 through 763 of SEQ ID NO:19, nucleotides 479 through 1099 of SEQ ID NO:19, nucleotides 503 through 1033 of SEQ ID NO:19, nucleotides 776 through 1066 of SEQ ID NO:19, nucleotides 776 through 1099 of SEQ ID NO:19, nucleotides 1061 through 1801 of SEQ ID NO:19, nucleotides 1232 through 1993 of SEQ ID NO:19, nucleotides 1283 through 1426 of SEQ ID NO:19, nucleotides 1283 through 1960 of SEQ ID NO:19, and nucleotides 1295 through 1939 of SEQ ID NO:19.

The invention also provides isolated genomic nucleic acids corresponding to the nucleic acids of the invention.

35 Another aspect of the invention provides isolated nucleic acids, preferably having a length of at least 15 nucleotides, that hybridize under conditions of moderate stringency to the nucleic acids encoding polypeptides of the invention. In preferred embodiments of the invention, such nucleic acids encode a polypeptide having HPR1 and/or HPR2 polypeptide activity, or comprise a nucleotide sequence that shares nucleotide sequence identity with the nucleotide sequences of the nucleic acids of the invention, wherein the percent nucleotide sequence identity is selected from the group consisting of: at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, at least 97.5%, at least 99%, and at least 99.5%.



5 Further provided by the invention are expression vectors and recombinant host cells comprising at least one nucleic acid of the invention, and preferred recombinant host cells wherein said nucleic acid is integrated into the host cell genome.

Also provided is a process for producing a polypeptide encoded by the nucleic acids of the invention, comprising culturing a recombinant host cell under conditions promoting expression of said polypeptide, wherein the recombinant host cell comprises at least one nucleic acid of the invention. A preferred process provided by the invention further comprises purifying said polypeptide. In another aspect of the invention, the polypeptide produced by said process is provided.

Further aspects of the invention are isolated antibodies that bind to the polypeptides of the invention, preferably monoclonal antibodies, also preferably humanized antibodies or humanized antibodies, and preferably wherein the antibody inhibits the activity of said polypeptides.

The invention additionally provides a method of designing an inhibitor of the polypeptides of the invention, the method comprising the steps of determining the three-dimensional structure of any such polypeptide, analyzing the three-dimensional structure for the likely binding sites of substrates, synthesizing a molecule that incorporates a predicted reactive site, and determining the polypeptide-inhibiting activity of the molecule.

In a further aspect of the invention, a method is provided for identifying compounds that alter HPR1 and/or HPR2 polypeptide activity comprising

- (a) mixing a test compound with a polypeptide of the invention; and
- (b) determining whether the test compound alters the HPR1 and/or HPR2 polypeptide activity of said polypeptide.

In another aspect of the invention, a method is provided identifying compounds that inhibit the binding activity of HPR1 and/or HPR2 polypeptides comprising

- (a) mixing a test compound with a polypeptide of the invention and a binding partner of said polypeptide; and
- (b) determining whether the test compound inhibits the binding activity of said polypeptide.

In preferred embodiments, the binding partner is a four alpha helix bundle cytokine; more preferably, the binding partner is selected from the group consisting of IL-6, OSM, LIF, CNTF, CLC, IL-12p35, and IL-23p19, and most preferably the binding partners are a soluble hematopoietin receptor such as EBI-3, soluble IL-6R alpha, cytokine-like factor-1 (CLF), IL-12p40, or a soluble form of HPR1 and/or HPR2 in conjunction with a four alpha helix bundle cytokine.

The invention also provides a method for increasing ligand-binding activity, comprising providing at least one compound selected from the group consisting of the polypeptides of the invention and agonists of said polypeptides; with a preferred embodiment of the method further comprising increasing said activity in a patient by administering at least one polypeptide of the invention.

5 Further provided by the invention is a method for decreasing ligand-binding activity, comprising providing at least one antagonist of the polypeptides of the invention; with a preferred embodiment of the method further comprising decreasing said activity in a patient by administering at least one antagonist of the polypeptides of the invention, and with a further preferred embodiment wherein the antagonist is an antibody that inhibits the activity of any of said polypeptides.

10 The invention additionally provides a method for treating a cell proliferation condition comprising administering at least one compound selected from the group consisting of the polypeptides of the invention and agonists of said polypeptides; with a preferred embodiment wherein the cell proliferation condition is selected from the group consisting of pancytopenia, leukopenia, anemia, thrombocytopenia, neurodegenerative disorders, and osteoporosis resulting from a lack of bone-  
15 forming cells.

The invention additionally provides a method for treating a metabolic condition comprising administering at least one compound selected from the group consisting of the polypeptides of the invention and agonists of said polypeptides; with a preferred embodiment wherein the metabolic condition is obesity.

20 The invention additionally provides a method for treating a reproductive hormone condition comprising administering at least one compound selected from the group consisting of the polypeptides of the invention and agonists of said polypeptides; with a preferred embodiment wherein the condition is selected from the group consisting of deficient mammary development and infertility.

In other aspects of the invention, a method is provided for treating a cell proliferation  
25 condition comprising administering an antagonist of the polypeptide of the invention; with a preferred embodiment wherein the cell proliferation condition is selected from the group consisting of leukemia, tumour metastasis, and osteoporosis resulting from an excess of bone-resorbing cells.

In other aspects of the invention, a method is provided for treating a metabolic condition comprising administering an antagonist of the polypeptide of the invention; with a preferred  
30 embodiment wherein the metabolic condition is selected from the group consisting of cachexia, wasting, and AIDS-related weight loss.

In other aspects of the invention, a method is provided for treating cancer conditions stimulated by reproductive hormones comprising administering an antagonist of the polypeptide of the invention; with a preferred embodiment wherein the condition is selected from the group consisting of  
35 breast cancer and prolactinoma.

In another embodiment of the invention, methods are provided for using HPR1 and HPR2 polypeptides and antagonists thereof as adjuvants.

A further embodiment of the invention provides a use for the polypeptides of the invention in the preparation of a medicament for treating a cell proliferation condition; with a preferred embodiment  
40 wherein the cell proliferation condition is selected from the group consisting of pancytopenia, leukopenia, anemia, thrombocytopenia, neurodegenerative disorders, and osteoporosis.

5 A further embodiment of the invention provides a use for the polypeptides of the invention in the preparation of a medicament for treating a metabolic condition; with a preferred embodiment wherein the metabolic condition is obesity.

A further embodiment of the invention provides a use for the polypeptides of the invention in the preparation of a medicament for treating a reproductive hormone condition; with a preferred  
 10 embodiment wherein the condition is selected from the group consisting of deficient mammary development and infertility.

### **DETAILED DESCRIPTION OF THE INVENTION**

#### **Similarities of HPR1 and HPR2 Structure to Other Hematopoietin Receptor Family Members**

We have identified HPR1 and HPR2, new human hematopoietin receptor polypeptides having  
 15 structural features characteristic of this polypeptide family; the amino acid sequence of an HPR1 polypeptide is provided in SEQ ID NO:4 and the amino acid sequence of three alternatively spliced forms of HPR2 polypeptide are provided in SEQ ID NOs 21, 23, and 25. We have also identified the murine homologue of human HPR1; the amino acid sequence of *Mus musculus* HPR1 is presented in SEQ ID NO:12. (The use of "HPR1" without a species designation refers to HPR1 polypeptides  
 20 generally, for example, human and/or murine, mammalian, or vertebrate HPR1 polypeptides.) Alignments showing the sequence similarities between HPR1, HPR2, and other hematopoietin receptors are presented in Tables 1, 2, and 3 in Example 1 below.

The typical structural elements common to members of the hematopoietin receptor polypeptide family include an extracellular region comprising at least one cytokine receptor domain,  
 25 and in most members of the family, a cytoplasmic region that in at least a subset of the hematopoietin receptor polypeptides comprises domains involved in intracellular signaling functions. A signal sequence is found at the N-terminus of hematopoietin receptor family polypeptides, and is followed, in N-to-C order, by an immunoglobulin (Ig)-like domain (in some members of the family), a cytokine receptor domain, three copies of a fibronectin repeat (in some members of the family), a  
 30 transmembrane domain or a glycosyl-phosphatidyl inositol (GPI) linkage to the membrane (except in soluble members of the family, which in most cases are soluble splice variant forms of transmembrane or membrane-linked hematopoietin receptor polypeptides), and a cytoplasmic domain (which is not present in soluble forms). The extracellular domain of hematopoietin receptor polypeptides extends from the N terminus to the transmembrane domain of the protein, and includes the cytokine receptor  
 35 domain and any Ig-like domains (approximately 100 amino acids in length) or fibronectin repeats (such as fibronectin type III repeats which are approximately 81-83 amino acids in length and are separated by spacer sequences of approximately 10 to 13 amino acids) that may be present in certain of the hematopoietin receptor polypeptides. There are key residues within the cytokine receptor domain, the two or four conserved cysteine residues and the WSXWS motif; substitutions of these residues are  
 40 likely to be associated with an altered function or lack of that function for the polypeptide. The cytokine receptor domain, which is approximately 200 amino acids in length, can be subdivided into two roughly equal subdomains - an N-terminal 'conserved cysteine' domain and a more C-terminal

- 5 'WSXWS' domain - separated by a proline-rich 'linker' stretch of four amino acids that allows the two subdomains to form a ligand binding site between them (Bravo and Heath, 2000, *EMBO J.* 19(11): 2399-2411).

The intracellular domain (also called "cytoplasmic domain") of the hematopoietin receptor polypeptides (in those family members that contain such a domain), extends from the transmembrane domain of the protein to the C terminus, and in the signaling receptor subgroup, includes regions involved in intracellular signal transduction functions. Although the amino acid sequence of the intracellular domain varies considerably between hematopoietin receptor polypeptides, there are a few regions that show some similarity between the members of the family and which have been determined to be involved in binding to members of the signal transduction cascade. "Box 1" is a stretch of 9 to 12 amino acids that begins about 9 amino acids C-terminal to the transmembrane domain, and has within it a conserved Ar-P-X-Al-P-X-P motif, where Ar is an aromatic amino acid (Trp, Phe, or Tyr) and Al is an aliphatic amino acid (Ala, Gly, Val, Leu, or Ile). About 8 amino acids C-terminal to Box 1 there is a conserved aromatic amino acid (usually Trp but also Phe or Tyr), and approximately 15 to 60 amino acids further C-terminal there is a motif of about 11 to 13 amino acids, "Box 2". While Box 1 is present in most of the hematopoietin receptor polypeptides, the Box 2 motif is present in a subset of the hematopoietin receptor family including gp130, GCSFR, LIF-R, the erythropoietin receptor (EPO-R), and several others. Mutations to residues within Box 1 or Box 2, or to the conserved aromatic residue between the Box 1 and Box 2 motifs, have inactivated the ability of the mutated receptor to stimulate cell proliferation upon the addition of ligand. A further conserved domain has been identified in the cytoplasmic domains of signaling cytokine receptors such as gp130, LIF-R, and G-CSFR: "Box 3". The Box 3 motif is about 10 to 15 amino acids located between approximately 70 and 150 amino acids C-terminal of the transmembrane domain, and has a rough match to a (P/T)VXGXGYXXQ consensus sequence. Cytoplasmic regions of these receptors containing Box 3 have been associated with a macrophage differentiation promoting activity (in the case of gp130) and a granulocyte differentiation promoting activity (in the case of G-CSFR) (Soede-Bobok and Touw, 1997, *J Mol Med* 75: 470-477); however, members of the LIF/IL-6 gp130-sharing family of hematopoietin receptors can also be involved in suppression of differentiation (see Ernst *et al.*, 1999, *J Biol Chem* 274(14): 9729-9737). Finally, the cytoplasmic domains of signaling hematopoietin receptor polypeptides contain several tyrosine residues that are potential sites for phosphorylation. Although hematopoietin receptors themselves do not generally have a protein kinase activity, they interact with and are phosphorylated by kinases within the JAK/STAT signal transduction pathways. Mutations in the Box 1 motif abolish the ability of certain of the signaling hematopoietin receptors to bind members of the Janus kinase (JAK) family, particularly JAK2 or JAK1 (Taner *et al.*, 1995, *J Biol Chem* 270(12): 6523-6530). Hematopoietin receptor-ligand interactions also activate the ERK/MAPK pathway, most likely through the phosphorylation of tyrosine residues in the cytoplasmic domains as the tyrosines at cytoplasmic positions 118 of gp130 (amino acid 759 of SEQ ID NO:8) and 115 of LIF-R (amino acid 974 of SEQ ID NO:6) are present within SHP2 binding sites (Schiemann *et al.*, 1997, *J Biol Chem* 272(26): 16631-

5 16636). The cytoplasmic tyrosine residues of signaling hematopoietin receptors and the amino acids around them are also important motifs for the recruitment and phosphorylation of signal-transducing STAT polypeptides (Hirano *et al.*, 2000, *Oncogene* 19: 2548-2556).

Human HPR1 polypeptide has a signal sequence extending from approximately amino acid 20 through amino acid 32 of SEQ ID NO:4, with the mature polypeptide produced by cleavage of this  
 10 signal sequence predicted to have an amino acid sequence beginning at amino acid 33 of SEQ ID NO:4. Human HPR1 has a cytokine receptor domain extending approximately from amino acid 33 through amino acid 241 of SEQ ID NO:4; three fibronectin repeats from approximately amino acid 242 of SEQ ID NO:4 to about amino acid 515 of SEQ ID NO:4; a transmembrane domain that begins approximately between amino acids 526 and 533 of SEQ ID NO:4 and extends to approximately  
 15 between amino acids 552 and 556 of SEQ ID NO:4 (defining a smaller 'core' transmembrane domain from amino acid 533 to amino acid 552 of SEQ ID NO:4 and an extended transmembrane domain from amino acid 526 to amino acid 556 of SEQ ID NO:4); and a cytoplasmic domain extending from the end of the transmembrane domain (i.e. beginning roughly between amino acids 553 and 557 of SEQ ID NO:4) and extending through the carboxyl terminus of the polypeptide (amino acid 745 of SEQ ID  
 20 NO:4). Therefore, human HPR1 polypeptide has an overall structure consistent with other hematopoietin receptor family members. The four conserved cysteine residues within the human HPR1 cytokine receptor domain are located at positions 43, 53, 81, and 94 of SEQ ID NO:4, and the human HPR1 WSXWS motif is located from amino acid 224 through amino acid 228 of SEQ ID NO:4. The human HPR1 N-terminal cytokine receptor subdomain containing four conserved cysteine residues  
 25 extends approximately from amino acid 33 of SEQ ID NO:4 to amino acid 134 of SEQ ID NO:4; the proline-rich linker is amino acids 135 through 138 of SEQ ID NO:4; and the WSXWS-containing C-terminal cytokine receptor subdomain extends from amino acid 139 to about amino acid 241 of SEQ ID NO:4. In human HPR1, as in several members of the hematopoietin receptor family, the cytokine receptor domain is followed by three fibronectin type III repeats; these repeats are located within the  
 30 human HPR1 amino acid sequence of SEQ ID NO:4 at the following approximate locations: amino acids 242 to 244 through 324 to 326, amino acids 336 to 337 through 419 to 422, and amino acids 430 to 433 through 514 to 515. Within its intracellular domain, human HPR1 polypeptide contains a good match to the Box 1 conserved motif from amino acid 563 through amino acid 573 of SEQ ID NO:4, a conserved downstream Trp residue (amino acid 581 of SEQ ID NO:4), and a Box 2 motif from amino  
 35 acid 631 to amino acid 641 of SEQ ID NO:4. The cytoplasmic domains of signaling hematopoietin receptor polypeptides contain several tyrosine residues that are potential sites for phosphorylation; in human HPR1, such tyrosines are located at positions 652, 683, and 721 of SEQ ID NO:4. Human HPR1 contains several instances of an Asp-containing motif within its cytoplasmic region. In the area overlapping the Box 2 location, human HPR1 has repeated amino acid sequences as shown in the  
 40 following table; these sequences form a consensus sequence of DKL(N/V)(T/Al), where Al is an aliphatic residue as described above. Other signaling hematopoietin receptors such as murine HPR1 (at

- 5 amino acids 600 through 604 of SEQ ID NO:12) and gp130 also contain at least one similar Asp-containing sequence in the region around and following the Box 2 location.

Repeat Sequence	Location in SEQ ID NO:4
DKLNL	amino acids 588 through 592
DSVNT	amino acids 597 through 601
DRILK	amino acids 603 through 607
DKLVI	amino acids 614 through 618
DKLVV	amino acids 619 through 623
DEART	amino acids 635 through 639

- 10 Variants, presumably splice variants, of human HPR1 are described in WO 00/75314: a 252-amino-acid form ("NR10.2"), a 652-amino-acid form ("NR10.1"), and a 662-amino-acid form ("NR10.3").
- 15 The 252-amino-acid form of HPR1 (SEQ ID NO:13) is identical to SEQ ID NO:4 through amino acid 238, and then has a divergent amino acid sequence from amino acid 239 through 252 of SEQ ID NO:13. This 252-amino-acid form of human HPR1 therefore does not contain the fibronectin type III repeats found in the full-length 745-amino-acid HPR1 of SEQ ID NO:4, or the transmembrane domain or the intracellular region of the SEQ ID NO:4 polypeptide. The 652-amino-acid form of HPR1 (SEQ
- 20 ID NO:14) is identical to SEQ ID NO:4 through amino acid 642, and then has a divergent amino acid sequence from amino acid 643 through 652 of SEQ ID NO:14.; and the 662-amino-acid form of HPR1 (SEQ ID NO:15) is identical to SEQ ID NO:4 through amino acid 651, and then has a divergent amino acid sequence from amino acid 652 through 662 of SEQ ID NO:15. The 652- and 662-amino-acid forms of human HPR1 therefore do not contain the tyrosine residues at positions 652, 683, and 721 of the intracellular region of the SEQ ID NO:4 polypeptide which are potential substrates for phosphorylation by kinases, such as those of the ERK/MAPK signaling pathways.

- 25 The Mus musculus HPR1 amino acid sequence of SEQ ID NO:12 has a signal sequence beginning approximately between amino acid 13 and amino acid 16 of SEQ ID NO:12 and extending approximately through amino acid 28 of SEQ ID NO:12, with the mature polypeptide produced by cleavage of this signal sequence predicted to have an amino acid sequence beginning at amino acid 29 of SEQ ID NO:12. Murine HPR1 has a cytokine receptor domain extending approximately from amino acid 29 through amino acid 224 of SEQ ID NO:12; three fibronectin repeats from approximately amino acid 225 of SEQ ID NO:12 to about amino acid 499 of SEQ ID NO:12; a transmembrane domain that begins approximately between amino acids 510 and 517 of SEQ ID NO:12 and extends to
- 30 approximately between amino acids 532 and 533 of SEQ ID NO:12 (defining a smaller 'core' transmembrane domain from amino acid 517 to amino acid 532 of SEQ ID NO:12 and an extended transmembrane domain from amino acid 510 to amino acid 533 of SEQ ID NO:12); and a cytoplasmic domain extending from the end of the transmembrane domain (i.e. beginning roughly between amino acids 533 and 534 of SEQ ID NO:12) and extending through the carboxyl terminus of the polypeptide
- 35 (amino acid 726 of SEQ ID NO:12). Therefore, murine HPR1 polypeptide has an overall structure consistent with other hematopoietin receptor family members. There are two conserved cysteine residues within the murine HPR1 cytokine receptor domain located at positions 39 and 49 of SEQ ID NO:12, and there are two additional cysteines in this region (although at non-conserved positions) at

5 amino acids 90 and 97 of SEQ ID NO:12. The murine HPR1 WSXWS motif is located from amino acid 207 through amino acid 211 of SEQ ID NO:12. The murine HPR1 N-terminal cytokine receptor subdomain containing two conserved cysteine residues (and two additional cysteine residues) extends approximately from amino acid 29 of SEQ ID NO:12 to amino acid 124 of SEQ ID NO:12; the proline-rich linker is amino acids 125 through 128 of SEQ ID NO:12; and the WSXWS-containing C-terminal  
 10 cytokine receptor subdomain extends from amino acid 129 to about amino acid 224 of SEQ ID NO:12. In murine HPR1, as in several members of the hematopoietin receptor family, the cytokine receptor domain is followed by three fibronectin type III repeats; these repeats are located within the murine HPR1 amino acid sequence of SEQ ID NO:12 at the following approximate locations: amino acids 225 to 227 through 307 to 309, amino acids 319 to 320 through 403 to 406, and amino acids 413 to  
 15 417 through 498 to 499. Within its intracellular domain, murine HPR1 polypeptide contains a good match to the Box 1 conserved motif from amino acid 547 through amino acid 557 of SEQ ID NO:12, a conserved downstream Trp residue (amino acid 565 of SEQ ID NO:12), and a Box 2 motif from amino acid 612 through amino acid 622 of SEQ ID NO:12. The cytoplasmic domains of signaling hematopoietin receptor polypeptides contain several tyrosine residues that are potential sites for  
 20 phosphorylation; in murine HPR1, such tyrosines are located at positions 633, 674, and 701 of SEQ ID NO:12.

Human HPR2 polypeptide has a signal sequence extending from approximately amino acid 11 through amino acid 23 of SEQ ID NO:21, with the mature polypeptide produced by cleavage of this signal sequence predicted to have an amino acid sequence beginning at amino acid 24 of SEQ ID  
 25 NO:21. The membrane-spanning (629 amino acids) form of HPR2 has an N-terminal Ig-like domain extending approximately from amino acid 24 through amino acid 124 of SEQ ID NO:21, a cytokine receptor domain extending approximately from amino acid 125 through an amino acid from 320 to 331 of SEQ ID NO:21; a transmembrane domain that begins approximately at amino acid 356 of SEQ ID NO:21 and extends to approximately amino acid 375 of SEQ ID NO:21; and a cytoplasmic domain  
 30 extending from the end of the transmembrane domain (i.e. beginning approximately at amino acid 376 of SEQ ID NO:21) and extending through the carboxyl terminus of the polypeptide (amino acid 629 of SEQ ID NO:21). Therefore, HPR2 polypeptide has an overall structure consistent with other hematopoietin receptor family members. The N-terminal Ig-like domain contains six cysteine residues at positions 30, 52, 59, 101, 105, and 115 of SEQ ID NO:21, the most conserved of which appear to be  
 35 the two cysteines at positions 52 and 101; the cysteines at positions 30, 115 (and to a lesser extent, at 105) also align with cysteines at similar positions in Ig or Ig-like domains. The HPR2 Ig-like domain appears to have the greatest degree of sequence similarity with members of the LIR (leukocyte Ig-like receptor) polypeptide family, particularly LIR-3 and LIR-4. The two conserved cysteine residues within the human HPR2 cytokine receptor domain are located at amino acid positions 133 and 144 of  
 40 SEQ ID NO:21, and the HPR2 version of the WSXWS motif, which has a glutamine residue at the second position of the motif rather than a serine residue, is located from amino acid 304 through amino acid 308 of SEQ ID NO:21. The HPR2 N-terminal cytokine receptor subdomain containing the two

5 conserved cysteine residues extends approximately from amino acid 125 of SEQ ID NO:21 to amino acid 219 of SEQ ID NO:21; the proline-rich linker (in this case, proline- and alanine-rich) is amino acids 220 through 223 of SEQ ID NO:21; and the 'WQXWS'-containing C-terminal cytokine receptor subdomain extends from amino acid 224 through an amino acid from 320 to 331 of SEQ ID NO:21. HPR2 does not contain the fibronectin type III repeats found in human and murine HPR1. Within its

10 intracellular domain, the membrane-spanning (629 amino acids) form of HPR2 contains a good match to the Box 1 conserved motif from amino acid 393 through amino acid 403 of SEQ ID NO:21, does not contain a Trp residue between Box 1 and Box2, and has a Box 2 motif from amino acid 430 to amino acid 440 of SEQ ID NO:21. There are also two matches to the Box 3 motif in this membrane-spanning HPR2 polypeptide, at amino acids 478 through 491 and at amino acids 605 through 618 of SEQ ID

15 NO:21. The cytoplasmic domains of signaling hematopoietin receptor polypeptides contain several tyrosine residues that are potential sites for phosphorylation; in human HPR2, such tyrosines are located at amino acid positions 397 (within the Box 1 motif), 429 (immediately N-terminal to the Box 2 motif), 450, 463, and 476 (just N-terminal of the most N-terminal Box 3 motif), and amino acids 484 and 611 (each of these last two amino acids is within a Box 3 motif) of SEQ ID NO:21. In several

20 respects, the membrane-spanning form of HPR2 shows similarity to the LIF-R hematopoietin receptor: both of these molecules have an Ig-like domain that is followed by a cytokine receptor domain having two (as compared to four) conserved cysteines; and both have Box 1, Box 2, and Box 3 motifs in their intracellular domains, and do not have a tryptophan residue between Box 1 and Box 2.

The HPR2-ex9 polypeptide of SEQ ID NO:23 (356 amino acids), created by alternative

25 splicing which removes exon 9 of the HPR2 coding sequence (see Example 1 below), is identical to the HPR2 629-amino-acid form from amino acid 1 through amino acid 348, but then diverges in sequence for the eight amino acids from amino acid 349 to the C terminus at amino acid 356. The HPR2-ex9 form does not contain a transmembrane region, and is expected to be a secreted form of HPR2 containing the HPR2 extracellular Ig-like and cytokine receptor domains. The HPR2-ex8-ex9

30 polypeptide of SEQ ID NO:25 (565 amino acids), created by alternative splicing which removes exons 8 and 9 of the HPR2 coding sequence (see Example 1 below), is identical to the HPR2 629-amino-acid form from amino acid 1 through amino acid 318, is missing the next 64 amino acids which include the transmembrane domain, but then shows identity between amino acid 319 through amino acid 565 of SEQ ID NO:25 and the C-terminal region of the 629-amino-acid form of HPR2. The HPR2-ex8-ex9

35 form is also expected to be a secreted form of HPR2 containing not only the HPR2 extracellular Ig-like and cytokine receptor domains, but also the C-terminal portion of the HPR2 protein which includes the Box 1, Box 2, and Box 3 motifs. A variant, presumably a splice variant, of human HPR2 is described in WO 00/73451: a 384-amino-acid form ("DCRS2"). This 384-amino-acid form of HPR2 (SEQ ID NO:26) is identical to SEQ ID NO:21 through amino acid 380, and then has a divergent amino acid

40 sequence from amino acid 381 through 384 of SEQ ID NO:26. This 384-amino-acid form of human HPR2 therefore does not contain the intracellular region of the SEQ ID NO:21 HPR2 polypeptide,



5 which contains the Box1, 2, and 3 motifs and intracellular tyrosine residues that are involved in the signaling (or signal transduction) function of the SEQ ID NO:21 HPR2 polypeptide.

The *Mus musculus* HPR2 amino acid sequence of SEQ ID NO:27 has a signal sequence beginning approximately between amino acid 8 and amino acid 11 and extending through amino acid 23 of SEQ ID NO:27, with the mature polypeptide produced by cleavage of this signal sequence  
 10 predicted to have an amino acid sequence beginning at amino acid 24 of SEQ ID NO:27. *Mus musculus* HPR2, like the membrane-spanning form of human HPR2, has an N-terminal Ig-like domain extending approximately from amino acid 24 through amino acid 124 of SEQ ID NO:27, a cytokine receptor domain extending approximately from amino acid 125 through an amino acid from 341 to 350 of SEQ ID NO:27; a transmembrane domain that begins approximately between amino acid 373 and  
 15 amino acid 380 of SEQ ID NO:27 and extends through approximately between amino acid 394 and amino acid 395 of SEQ ID NO:27 (defining a smaller 'core' transmembrane domain from amino acid 380 to amino acid 394 of SEQ ID NO:27 and an extended transmembrane domain from amino acid 373 to amino acid 395 of SEQ ID NO:27); and a cytoplasmic domain extending from the end of the transmembrane domain (i.e. beginning approximately at amino acid 395 or at amino acid 396 of SEQ  
 20 ID NO:27) and extending through the carboxyl terminus of the polypeptide (amino acid 644 of SEQ ID NO:27). Therefore, murine HPR2 polypeptide has an overall structure consistent with other hematopoietin receptor family members. The N-terminal Ig-like domain contains six cysteine residues at positions 30, 52, 59, 101, 105, and 115 of SEQ ID NO:27, the most conserved of which appear to be the two cysteines at positions 52 and 101; the cysteines at positions 30, 115 (and to a lesser extent, at  
 25 105) also align with cysteines at similar positions in Ig or Ig-like domains. As with human HPR2, the murine HPR2 Ig-like domain appears to have the greatest degree of sequence similarity with members of the LIR (leukocyte Ig-like receptor) polypeptide family. The two conserved cysteine residues within the human HPR2 cytokine receptor domain are located at amino acid positions 133 and 144 of SEQ ID NO:27, and the murine HPR2 version of the "WSXWS" motif, which like human HPR2 has a  
 30 glutamine residue at the second position of the motif rather than a serine residue, is located from amino acid 324 through amino acid 328 of SEQ ID NO:27. The murine HPR2 polypeptide contains an insert of 20 amino acids relative to the human HPR2 polypeptide; this insert region extends from amino acid 297 through amino acid 316 of SEQ ID NO:27, and is a perfect repeat of amino acids 317 through 336 of SEQ ID NO:27. Therefore, in the SEQ ID NO:27 form of murine HPR2, there is a second WQXWS  
 35 motif at amino acids 304 through 308 of SEQ ID NO:27. The murine HPR2 N-terminal cytokine receptor subdomain containing the two conserved cysteine residues extends approximately from amino acid 125 of SEQ ID NO:27 to amino acid 219 of SEQ ID NO:27; the proline-rich linker (in this case, proline- and alanine-rich) is amino acids 220 through 223 of SEQ ID NO:27; and the C-terminal cytokine receptor subdomain containing the two repeats of the WQXWS motif extends from amino  
 40 acid 224 through an amino acid from 340 to 350 of SEQ ID NO:27. Murine HPR2 does not contain the fibronectin type III repeats found in human and murine HPR1. Within its intracellular domain, this membrane-spanning form of murine HPR2 contains a good match to the Box 1 conserved motif from

5 amino acid 412 through amino acid 422 of SEQ ID NO:27, does not contain a Trp residue between Box 1 and Box2, and has a Box 2 motif from amino acid 449 to amino acid 459 of SEQ ID NO:27. There are also two matches to the Box 3 motif in this murine membrane-spanning HPR2 polypeptide, at amino acids 498 through 511 and at amino acids 620 through 633 of SEQ ID NO:27. The cytoplasmic domains of signaling hematopoietin receptor polypeptides contain several tyrosine residues that are potential sites for phosphorylation; in murine HPR2, such tyrosines are located at amino acid positions 416 (within the Box 1 motif), 448 (immediately N-terminal to the Box 2 motif), 469, and 496 (just N-terminal of the most N-terminal Box 3 motif), and amino acids 504 and 626 (each of these last two amino acids is within a Box 3 motif) of SEQ ID NO:27. There is an additional intracellular tyrosine located at position 542 of SEQ ID NO:27. As with the membrane-spanning form of human HPR2, 15 murine HPR2 shows similarity to the LIF-R hematopoietin receptor.

Each of the HPR1 and the HPR2 groups of related polypeptides therefore contains a distinct subset of the several features characteristic of at least some members of the hematopoietin receptor family. The skilled artisan will recognize that the boundaries of the regions of the HPR1 and HPR2 polypeptides described above are approximate and that the precise boundaries of such domains, as for example the boundaries of the transmembrane region (which can be predicted by using computer programs available for that purpose), can also differ from member to member within the hematopoietin receptor polypeptide family. 20

The hematopoietin receptor polypeptide family is highly to moderately conserved between species, with the family members within a particular species exhibiting some sequence conservation, particularly with respect to the conserved domains and residues described above. Subfamilies of the hematopoietin receptor polypeptide family can be defined on the basis of structure, for example the Ig-like domain containing members, or the fibronectin repeat containing members. It is also possible to group hematopoietin receptor polypeptides according to the length of the cytoplasmic domain, with those receptors having a longer cytoplasmic domain being more likely to be signaling receptors. 25 Subgroups of the hematopoietin receptor family can also be defined on the basis of a shared common signaling receptor present in several different combinations of heteromeric receptors. For example, the gp130 signaling receptor is found in separate complexes with LIF-R, IL-6R alpha or a soluble form of IL-6R alpha, and CNTFR alpha; monomeric forms or multimeric combinations of these receptor components bind to IL-6, OSM, LIF, and/or CNTF; thus a "gp130-sharing group" subfamily would 30 include these hematopoietin receptor polypeptides and be associated with this group of cytokines. Another group of hematopoietin receptors are those which associate with a ligand comprising at least two soluble polypeptides. For example, the IL-12 receptor associates with the combination of the p40 polypeptide, similar in structure to soluble forms of hematopoietin receptors such as soluble IL-6R alpha, and the four alpha helix bundle p35 polypeptide. The IL-12 p40 subunit can also associate with 35 another four alpha helix bundle cytokine called p19; when p40 binds p19 the resulting combination has been named "IL-23" and has been shown to bind to the IL-12R beta 1 receptor subunit, but not the signaling IL-12R beta 2 receptor subunit (Oppmann *et al.*, 2000, *Immunity* 13: 715-725). Thus the 40

5 p40-p19 complex is likely to bind a different IL-12RB2-like signaling receptor subunit, such as HPR2, HPR1, GCSFR, or gp130. As another example, CNTFR alpha, gp130, and LIFR can each associate with a combination of the soluble receptor cytokine-like factor-1 (CLF-1) and cardiotrophin-like cytokine (CLC), with CLF-1 and CLC analogous to p40 and p35, respectively (Elson *et al.*, 2000, *Nat Neurosci* 3(9): 867-872). The cytokine receptor domains of HPR1 and HPR2 are similar in sequence  
 10 to those of gp130, IL-6R beta, IL-12RB2, GCSFR, LIFR, leptin receptor, prolactin receptor, and other members of the hematopoietin receptor family, with HPR1 showing the greatest degree of similarity to gp130 and IL-6R beta, and HPR2 showing the greatest degree of similarity to gp130 and IL-12RB2. Because HPR1 and HPR2 each have a substantial cytoplasmic domain and are most similar in sequence to gp130, HPR1 and HPR2 are likely to be new signaling members of the "gp130-sharing" subfamily  
 15 of hematopoietin receptors; however, HPR2 may also share attributes of the IL-12RB2 receptor subunit, such as involvement in modulation of the balance between Th1 and Th2 immune responses. Expression of HPR1 and HPR2 has been detected by PCR amplification from tissue-specific cDNA libraries in several cell types including COS-1 cells, 293MSR cells, the B cell lines CB23 and MP-1, the B cell lymphoma lines Daudi, and Raji, the T cell leukemia line HSB2, and the promonocytic leukemia line U937. HPR2 mRNA expression appears to be more prevalent than HPR1 expression in the B cell derived lines, while HPR1 mRNA expression appears to be more prevalent than HPR2 expression in the T cell derived and monocyte lines. EBI-3 is a p40-like soluble hematopoietin receptor polypeptide; FACS analysis has shown that EBI-3-Fc fusion polypeptides bind to cells expressing HPR1 and HPR2 such as COS-1 cells, 293MSR cells, and CB23 and MP-1 cells, indicating  
 20 that EBI-3 is a potential binding partner of HPR1 and HPR2, most likely in conjunction with a four alpha helix bundle cytokine such as IL-6, OSM, LIF, CNTF, CLC, IL-12p35, or IL-23p19.

#### **Biological Activities and Functions of HPR1 and HPR2 Polypeptides**

PCR amplification from tissue-specific cDNA libraries was performed to detect HPR1 or  
 30 HPR2 cDNA sequences. The results of these experiments show that HPR1 transcripts are expressed in a wide variety of fetal and adult human cells, including testis, lung, placenta, pancreas, prostate, peripheral blood cells, thymus, stomach, and skin cells; as well as in various cell lines including U937 cells, the leukemia cell line HSB2, LX-1/GI-117 lung carcinoma cells, GI-112 colon adenocarcinoma cells, the B cell lines MP-1 and CB23, COS-1 cells, and 293MSR cells. HPR2 transcripts are present  
 35 in a similarly diverse group of adult and fetal human cell types, including placenta, lung, kidney, pancreas, prostate, testis, colon, LX-1/GI-117 lung carcinoma cells, tonsil/CX-1 cells, lymph node, GI-112 colon adenocarcinoma cells, heart, brain, spleen, thymus, ovary, small intestine, fetal brain, fetal lung/heart, fetal spleen, fetal thymus, esophagus, stomach, and skin; and in various cell lines such as the B cell lines MP-1 and CB23, Daudi cells, Raji cells, HSB2 cells, COS-1 cells, and 293MSR cells.

40 Typical biological activities or functions associated with HPR1 and HPR2 polypeptides are ligand-binding activity, intracellular signaling activity, cell proliferation stimulatory activity, cell proliferation inhibitory activity, cell differentiation stimulatory activity, and cell differentiation

5 inhibitory activity. HPR1 and HPR2 polypeptides having ligand-binding activity bind to cytokine or growth factor ligand molecules of the four alpha helix bundle family of cytokines, and in particular are likely to bind cytokines such as IL-6, OSM, LIF, CNTF, CLC, IL-12p35, and IL-23p19, and/or soluble hematopoietin receptors such as EBI-3, soluble IL-6R alpha, cytokine-like factor-1 (CLF), IL-12p40, or a soluble form of HPR1 and/or HPR2. This ligand-binding activity is associated with the extracellular  
10 cytokine receptor domain of HPR1 polypeptides. Thus, for uses requiring ligand-binding activity, preferred HPR1 and HPR2 polypeptides include those having at least one cytokine receptor domain and exhibiting ligand-binding activity. Preferred HPR1 and HPR2 polypeptides further include oligomers or fusion polypeptides comprising at least one cytokine receptor portion of one or more HPR1 and/or HPR2 polypeptides, and fragments of any of these polypeptides that have ligand-binding activity. The  
15 ligand-binding activity of HPR1 and HPR2 polypeptides may be determined, for example, by any standard assay to measure binding of labeled ligand or by a competitive binding assay, all of which are described more extensively below. HPR1 and HPR2 polypeptides having intracellular signaling activity bind ligand molecules when in association with other receptor polypeptides to form a homo- or heteromeric complex, with ligand binding initiating a signaling cascade. The intracellular signaling  
20 activity is associated with the cytoplasmic domain of certain HPR1 and HPR2 polypeptides. Thus, for uses requiring intracellular signaling activity, preferred HPR1 and HPR2 polypeptides include those having the cytoplasmic domain, and in particular having certain conserved domains (such as the Box 1 motif, the Trp residue at position 581 of SEQ ID NO:4, the Box 2 motif, the Asp-containing motifs between amino acids 588 and 639 of SEQ ID NO:4, or the Box 3 motif) and conserved cytoplasmic  
25 tyrosine residues, and exhibiting intracellular signaling biological activity. Preferred HPR1 and HPR2 polypeptides further include oligomers or fusion polypeptides comprising at least one cytoplasmic portion of one or more HPR1 and/or HPR2 polypeptides, and fragments of any of these polypeptides that have intracellular signaling activity. The intracellular signaling activity of HPR1 and HPR2 polypeptides may be determined, for example, through assays to detect phosphorylation of the HPR1  
30 polypeptide, the HPR2 polypeptide, or downstream polypeptides in signaling cascades such as the JAK/STAT or ERK/MAPK pathways, or in assays that measure biological activities related to the signal transmission, such as stimulation or suppression of cell proliferation, differentiation, or activation. One example of an assay to measure cytokine-binding and cell-proliferation activity involves expressing a polypeptide of the invention in Ba/F3 cells, exposing the polypeptide-expressing  
35 cells to radioactively labeled cytokine, and measuring specific cytokine binding to cells and uptake of <sup>3</sup>H-thymidine by cells in response to cytokine, as described in Presky *et al.*, 1996, *Proc Natl Acad Sci USA* 93: 14002-14007. Further examples of such assays are described herein and in Ernst *et al.*, 1999, *J Biol Chem* 274(14): 9729-9737. Soluble forms of hematopoietin receptors comprising one or more extracellular domains of the hematopoietin receptor, such as soluble forms of HPR1 and HPR2, may  
40 also be used in assays to measure their effect on cell growth, proliferation, differentiation, or activation; in such assays the cells are contacted with the soluble form of the receptor and their growth,

5 proliferation, differentiation, or activation is measured, for example by measuring the incorporation of radioactive thymidine or by microscopic examination of treated and untreated cells.

The terms "HPR1 polypeptide activity" and "HPR2 polypeptide activity," as used herein, include any one or more of the following: ligand-binding activity and intracellular signaling activity (which includes effects on cell growth, proliferation, differentiation, or activation), as well as the *ex vivo* and *in vivo* activities of HPR1 and HPR2 polypeptides. The degree to which HPR1 and HPR2 polypeptides and fragments and other derivatives of these polypeptides exhibit these activities can be determined by standard assay methods as disclosed herein; those of skill in the art will appreciate that other, similar types of assays can be used to measure HPR1 and HPR2 biological activities.

Another aspect of the biological activity of HPR1 and HPR2 polypeptides is the ability of members of these polypeptide families to bind particular binding partners such as cytokines, other hematopoietin receptor polypeptides, and intracellular signaling polypeptides, with the cytokine receptor domain binding to cytokines and the intracellular signaling domain binding to intracellular signaling polypeptides such as members of the JAK and SHP polypeptide families. The term "binding partner," as used herein, includes ligands, receptors, substrates, antibodies, other hematopoietin receptor polypeptides, the same HPR1 or HPR2 polypeptide (in the case of homotypic interactions), and any other molecule that interacts with an HPR1 or an HPR2 polypeptide through contact or proximity between particular portions of the binding partner and the HPR1 or HPR2 polypeptide. Because the cytokine receptor domains of HPR1 and HPR2 polypeptides bind to cytokines, an HPR1 or HPR2 cytokine receptor domain when expressed as a separate fragment from the rest of an HPR1 or HPR2 polypeptide, or as a soluble polypeptide, fused for example to an immunoglobulin Fc domain, is expected to disrupt the binding of endogenous HPR1 and/or HPR2 polypeptides to their binding partners. By binding to one or more binding partners, the separate cytokine receptor domain polypeptide likely prevents binding by the native HPR1 and/or HPR2 polypeptide(s), and so acts in a dominant negative fashion to inhibit the biological activities mediated via binding of HPR1 and/or HPR2 polypeptides to cytokines. Assays for evaluating the biological activities and partner-binding properties of HPR1 and HPR2 polypeptides are described further herein.

HPR1 and HPR2 polypeptides are involved in cell proliferation, differentiation, or activation diseases or conditions, that share as a common feature ligand-binding activity in their etiology. More specifically, the following cell proliferation conditions are those that are known or are likely to involve the biological activities of HPR1 and/or HPR2 polypeptides: pancytopenia, leukopenia, anemia, thrombocytopenia, neurodegenerative disorders, osteoporosis resulting from a lack of bone-forming cells, leukemia, tumour metastasis, and osteoporosis resulting from an excess of bone-resorbing cells. In addition, the following metabolic conditions involving hematopoietin receptor ligands such as leptin are those that are known or are likely to involve the biological activities of HPR1 and/or HPR2 polypeptides: obesity, cachexia, wasting, and AIDS-related weight loss. Also, the following prolactin-related conditions are those that are known or are likely to involve the biological activities of HPR1 and/or HPR2 polypeptides: deficient mammary development, infertility, breast cancer, and

5 prolactinoma. Blocking or inhibiting the interactions between members of the HPR1 and HPR2 polypeptide families and their substrates, ligands, receptors, binding partners, and or other interacting polypeptides is an aspect of the invention and provides methods for treating or ameliorating these diseases and conditions through the use of inhibitors of HPR1 and/or HPR2 polypeptide activity. Examples of such inhibitors or antagonists are described in more detail below. For certain conditions  
10 involving too little HPR1 or HPR2 polypeptide activity, methods of treating or ameliorating these conditions comprise increasing the amount or activity of HPR1 or HPR2 polypeptides by providing isolated HPR1 or HPR2 polypeptides or active fragments or fusion polypeptides thereof, or by providing compounds (agonists) that activate endogenous or exogenous HPR1 or HPR2 polypeptides.

#### **HPR1 and HPR2 Polypeptides**

15 An HPR1 polypeptide is a polypeptide that shares a sufficient degree of amino acid identity or similarity to the human HPR1 polypeptide of SEQ ID NO:4 or the murine HPR1 polypeptide of SEQ ID NO:12 to (A) be identified by those of skill in the art as a polypeptide likely to share particular structural domains and/or (B) have biological activities in common with the HPR1 polypeptides of SEQ ID NO:4 and SEQ ID NO:12 and/or (C) bind to antibodies that also specifically bind to other  
20 HPR1 polypeptides. An HPR2 polypeptide is a polypeptide that shares a sufficient degree of amino acid identity or similarity to the HPR2 polypeptides of SEQ ID NOs 21, 23, 25, and 27 to (A) be identified by those of skill in the art as a polypeptide likely to share particular structural domains and/or (B) have biological activities in common with the HPR2 polypeptides of SEQ ID NOs 21, 23, 25, and 27 and/or (C) bind to antibodies that also specifically bind to other HPR2 polypeptides. HPR1 and  
25 HPR2 polypeptides can be isolated from naturally occurring sources, or have the same structure as naturally occurring HPR1 or HPR2 polypeptides, or can be produced to have structures that differ from naturally occurring HPR1 or HPR2 polypeptides. Polypeptides derived from any HPR1 or HPR2 polypeptide by any type of alteration (for example, but not limited to, insertions, deletions, or substitutions of amino acids; changes in the state of glycosylation of the polypeptide; refolding or  
30 isomerization to change its three-dimensional structure or self-association state; and changes to its association with other polypeptides or molecules) are also HPR1 or HPR2 polypeptides, respectively. Therefore, the polypeptides provided by the invention include polypeptides characterized by amino acid sequences similar to those of the HPR1 and HPR2 polypeptides described herein, but into which modifications are naturally provided or deliberately engineered. A polypeptide that shares biological  
35 activities in common with members of the HPR1 and/or HPR2 polypeptide family is a polypeptide having HPR1 and/or HPR2 polypeptide activity. Examples of biological activities exhibited by HPR1 and/or HPR2 polypeptides include, without limitation, ligand-binding activity and intracellular signaling.

40 The present invention provides both full-length and mature forms of HPR1 and HPR2 polypeptides. Full-length polypeptides are those having the complete primary amino acid sequence of the polypeptide as initially translated. The amino acid sequences of full-length polypeptides can be obtained, for example, by translation of the complete open reading frame ("ORF") of a cDNA

5 molecule. Several full-length polypeptides can be encoded by a single genetic locus if multiple mRNA forms are produced from that locus by alternative splicing or by the use of multiple translation initiation sites. The "mature form" of a polypeptide refers to a polypeptide that has undergone post-translational processing steps such as cleavage of the signal sequence or proteolytic cleavage to remove a prodomain. Multiple mature forms of a particular full-length polypeptide may be produced, for  
10 example by cleavage of the signal sequence at multiple sites, or by differential regulation of proteases that cleave the polypeptide. The mature form(s) of such polypeptide can be obtained by expression, in a suitable mammalian cell or other host cell, of a nucleic acid molecule that encodes the full-length polypeptide. The sequence of the mature form of the polypeptide may also be determinable from the amino acid sequence of the full-length form, through identification of signal sequences or protease  
15 cleavage sites. The HPR1 and HPR2 polypeptides of the invention also include those that result from post-transcriptional or post-translational processing events such as alternate mRNA processing which can yield alternative splice forms of HPR1 or HPR2 such as a truncated but biologically active polypeptide or, for example, a naturally occurring soluble form of the polypeptide. Also encompassed within the invention are variations attributable to proteolysis such as differences in the N- or C-termini  
20 upon expression in different types of host cells, due to proteolytic removal of one or more terminal amino acids from the polypeptide (generally from 1-5 terminal amino acids).

The invention further includes HPR1 and HPR2 polypeptides with or without associated native-pattern glycosylation. Polypeptides expressed in yeast or mammalian expression systems (*e.g.*, COS-1 or CHO cells) can be similar to or significantly different from a native polypeptide in molecular  
25 weight and glycosylation pattern, depending upon the choice of expression system. Expression of polypeptides of the invention in bacterial expression systems, such as *E. coli*, provides non-glycosylated molecules. Further, a given preparation can include multiple differentially glycosylated species of the polypeptide. Glycosyl groups can be removed through conventional methods, in particular those utilizing glycopeptidase. In general, glycosylated polypeptides of the invention can be  
30 incubated with a molar excess of glycopeptidase (Boehringer Mannheim).

Species homologues of HPR1 and HPR2 polypeptides and of nucleic acids encoding them are also provided by the present invention. As used herein, a "species homologue" is a polypeptide or nucleic acid with a different species of origin from that of a given polypeptide or nucleic acid, but with significant sequence similarity to the given polypeptide or nucleic acid, as determined by those of skill  
35 in the art. Species homologues can be isolated and identified by making suitable probes or primers from polynucleotides encoding the amino acid sequences provided herein and screening a suitable nucleic acid source from the desired species. The invention also encompasses allelic variants of HPR1 and HPR2 polypeptides and nucleic acids encoding them; that is, naturally-occurring alternative forms of such polypeptides and nucleic acids in which differences in amino acid or nucleotide sequence are  
40 attributable to genetic polymorphism (allelic variation among individuals within a population).

Fragments of the HPR1 and HPR2 polypeptides of the present invention are encompassed by the present invention and can be in linear form or cyclized using known methods, for example, as

5 described in Saragovi, et al., *Bio/Technology* 10, 773-778 (1992) and in McDowell, et al., *J. Amer. Chem. Soc.* 114 9245-9253 (1992). Polypeptides and polypeptide fragments of the present invention, and nucleic acids encoding them, include polypeptides and nucleic acids with amino acid or nucleotide sequence lengths that are at least 25% (more preferably at least 50%, or at least 60%, or at least 70%, and most preferably at least 80%) of the length of an HPR1 polypeptide or of an HPR2 polypeptide, 10 and have at least 60% sequence identity (more preferably at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, at least 97.5%, or at least 99%, and most preferably at least 99.5%) with that HPR1 or HPR2 polypeptide or encoding nucleic acid, where sequence identity is determined by comparing the amino acid sequences of the polypeptides when aligned so as to maximize overlap and identity while minimizing sequence gaps. Also included in the present invention 15 are polypeptides and polypeptide fragments, and nucleic acids encoding them, that contain or encode a segment preferably comprising at least 8, or at least 10, or preferably at least 15, or more preferably at least 20, or still more preferably at least 30, or most preferably at least 40 contiguous amino acids. Such polypeptides and polypeptide fragments may also contain a segment that shares at least 70% sequence identity (more preferably at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, 20 at least 95%, at least 97.5%, or at least 99%, and most preferably at least 99.5%) with any such segment of any of the HPR1 or HPR2 polypeptides, where sequence identity is determined by comparing the amino acid sequences of the polypeptides when aligned so as to maximize overlap and identity while minimizing sequence gaps. The percent identity can be determined by visual inspection and mathematical calculation. Preferably, the comparison is done using a computer program. An 25 exemplary, preferred computer program is the Genetics Computer Group (GCG; Madison, WI) Wisconsin package version 10.0 program, 'GAP.' The preferred default parameters for the 'GAP' program includes: (1) The GCG implementation of comparison matrices for nucleotides and amino acids; such as a unary comparison matrix (containing a value of 1 for identities and 0 for non-identities) for nucleotides, and the weighted comparison matrix of Gribskov and Burgess, *Nucl. Acids Res.* 30 14:6745, 1986, as described by Schwartz and Dayhoff, eds., *Atlas of Polypeptide Sequence and Structure*, National Biomedical Research Foundation, pp. 353-358, 1979; (2) a penalty of 30 for each gap and an additional penalty of 1 for each symbol in each gap for amino acid sequences, or penalty of 50 for each gap and an additional penalty of 3 for each symbol in each gap for nucleotide sequences; (3) no penalty for end gaps; and (4) no maximum penalty for long gaps. Another program useful for 35 determining percent identify is the BESTFIT program, also available from the University of Wisconsin as part of the GCG computer package. Default parameters for using the BESTFIT program are the same as those described above for using the GAP program. Other programs used by those skilled in the art of sequence comparison can also be used, such as, for example, the UW-BLAST 2.0 algorithm or the BLASTN program version 2.0.9, available for use *via* the National Library of Medicine website: 40 [ncbi.nlm.nih.gov/gorf/wblast2.cgi](http://ncbi.nlm.nih.gov/gorf/wblast2.cgi). Standard default parameter settings for UW-BLAST 2.0 are described at the following Internet site: [blast.wustl.edu/blast/README.html#References](http://blast.wustl.edu/blast/README.html#References). In addition, the BLAST algorithm uses the BLOSUM62 amino acid scoring matrix, and optional parameters that can



5 be used are as follows: (A) inclusion of a filter to mask segments of the query sequence that have low compositional complexity (as determined by the SEG program of Wootton and Federhen (Computers and Chemistry, 1993); also see Wootton and Federhen, 1996, Analysis of compositionally biased regions in sequence databases, *Methods Enzymol.* **266**: 554-71) or segments consisting of short-periodicity internal repeats (as determined by the XNU program of Claverie and States (Computers and  
10 Chemistry, 1993)), and (B) a statistical significance threshold for reporting matches against database sequences, or E-score (the expected probability of matches being found merely by chance, according to the stochastic model of Karlin and Altschul (1990); if the statistical significance ascribed to a match is greater than this E-score threshold, the match will not be reported.); preferred E-score threshold values are 0.5, or in order of increasing preference, 0.25, 0.1, 0.01, 0.001, 0.0001, 1e-10, 1e-20, 1e-30, 1e-40,  
15 1e-50, 1e-75, or 1e-100.

"An isolated polypeptide consisting essentially of an amino acid sequence" means that the polypeptide may have, in addition to said amino acid sequence, additional material covalently linked to either or both ends of the polypeptide, said additional material preferably between 1 and 10,000 additional amino acids covalently linked to either end, each end, or both ends of polypeptide, and more  
20 preferably between 1 and 1,000 additional amino acids covalently linked to either end, each end, or both ends of the polypeptide, and most preferably between 1 and 100 additional amino acids covalently linked to either end, each end, or both ends of the polypeptide. In preferred embodiments, covalent linkage of additional amino acids to either end, each end, or both ends of the polypeptide results in a novel combined amino acid sequence that is neither naturally occurring nor disclosed in the art.

25 The present invention also provides for soluble forms of HPR1 and HPR2 polypeptides comprising or consisting essentially of certain fragments or domains of these polypeptides, and particularly those comprising the extracellular domain or one or more fragments of the extracellular domain. Soluble polypeptides are polypeptides that are capable of being secreted from the cells in which they are expressed. In such forms part or all of the intracellular and transmembrane domains of  
30 the polypeptide are deleted such that the polypeptide is fully secreted from the cell in which it is expressed. The intracellular and transmembrane domains of polypeptides of the invention can be identified in accordance with known techniques for determination of such domains from sequence information. Soluble HPR1 and HPR2 polypeptides also include those polypeptides which include part of the transmembrane region, provided that the soluble HPR1 or HPR2 polypeptide is capable of being  
35 secreted from a cell, and preferably retains HPR1 and/or HPR2 polypeptide activity. Soluble HPR1 and HPR2 polypeptides further include oligomers or fusion polypeptides comprising the extracellular portion of at least one HPR1 or HPR2 polypeptide, and fragments of any of these polypeptides that have HPR1 and/or HPR2 polypeptide activity. A secreted soluble polypeptide can be identified (and distinguished from its non-soluble membrane-bound counterparts) by separating intact cells which  
40 express the desired polypeptide from the culture medium, e.g., by centrifugation, and assaying the medium (supernatant) for the presence of the desired polypeptide. The presence of the desired polypeptide in the medium indicates that the polypeptide was secreted from the cells and thus is a

5 soluble form of the polypeptide. The use of soluble forms of HPR1 or HPR2 polypeptides is advantageous for many applications. Purification of the polypeptides from recombinant host cells is facilitated, since the soluble polypeptides are secreted from the cells. Moreover, soluble polypeptides are generally more suitable than membrane-bound forms for parenteral administration and for many enzymatic procedures.

10 In another aspect of the invention, preferred polypeptides comprise various combinations of HPR1 and/or HPR2 polypeptide domains, such as the cytokine receptor domain and the intracellular signaling domain. Accordingly, polypeptides of the present invention and nucleic acids encoding them include those comprising or encoding two or more copies of a domain such as the cytokine receptor domain, two or more copies of a domain such as the intracellular signaling domain, or at least one copy  
15 of each domain, and these domains can be presented in any order within such polypeptides.

Further modifications in the peptide or DNA sequences can be made by those skilled in the art using known techniques. Modifications of interest in the polypeptide sequences can include the alteration, substitution, replacement, insertion or deletion of a selected amino acid. For example, one or more of the cysteine residues can be deleted or replaced with another amino acid to alter the  
20 conformation of the molecule, an alteration which may involve preventing formation of incorrect intramolecular disulfide bridges upon folding or renaturation. Techniques for such alteration, substitution, replacement, insertion or deletion are well known to those skilled in the art (see, e.g., U.S. Pat. No. 4,518,584). As another example, N-glycosylation sites in the polypeptide extracellular domain can be modified to preclude glycosylation, allowing expression of a reduced carbohydrate analog in  
25 mammalian and yeast expression systems. N-glycosylation sites in eukaryotic polypeptides are characterized by an amino acid triplet Asn-X-Y, wherein X is any amino acid except Pro and Y is Ser or Thr. Appropriate substitutions, additions, or deletions to the nucleotide sequence encoding these triplets will result in prevention of attachment of carbohydrate residues at the Asn side chain. Alteration of a single nucleotide, chosen so that Asn is replaced by a different amino acid, for example,  
30 is sufficient to inactivate an N-glycosylation site. Alternatively, the Ser or Thr can be replaced with another amino acid, such as Ala. Known procedures for inactivating N-glycosylation sites in polypeptides include those described in U.S. Patent 5,071,972 and EP 276,846. Additional variants within the scope of the invention include polypeptides that can be modified to create derivatives thereof by forming covalent or aggregative conjugates with other chemical moieties, such as glycosyl groups,  
35 lipids, phosphate, acetyl groups and the like. Covalent derivatives can be prepared by linking the chemical moieties to functional groups on amino acid side chains or at the N-terminus or C-terminus of a polypeptide. Conjugates comprising diagnostic (detectable) or therapeutic agents attached thereto are contemplated herein. Preferably, such alteration, substitution, replacement, insertion or deletion retains the desired activity of the polypeptide or a substantial equivalent thereof. One example is a variant that  
40 binds with essentially the same binding affinity as does the native form. Binding affinity can be measured by conventional procedures, e.g., as described in U.S. Patent No. 5,512,457 and as set forth herein.

5 Other derivatives include covalent or aggregative conjugates of the polypeptides with other polypeptides or polypeptides, such as by synthesis in recombinant culture as N-terminal or C-terminal fusions. Examples of fusion polypeptides are discussed below in connection with oligomers. Further, fusion polypeptides can comprise peptides added to facilitate purification and identification. Such peptides include, for example, poly-His or the antigenic identification peptides described in U.S. Patent  
10 No. 5,011,912 and in Hopp et al., *Bio/Technology* 6:1204, 1988. One such peptide is the FLAG<sup>®</sup> peptide, which is highly antigenic and provides an epitope reversibly bound by a specific monoclonal antibody, enabling rapid assay and facile purification of expressed recombinant polypeptide. A murine hybridoma designated 4E11 produces a monoclonal antibody that binds the FLAG<sup>®</sup> peptide in the presence of certain divalent metal cations, as described in U.S. Patent 5,011,912. The 4E11 hybridoma  
15 cell line has been deposited with the American Type Culture Collection under accession no. HB 9259. Monoclonal antibodies that bind the FLAG<sup>®</sup> peptide are available from Eastman Kodak Co., Scientific Imaging Systems Division, New Haven, Connecticut.

Encompassed by the invention are oligomers or fusion polypeptides that contain an HPR1 polypeptide and/or an HPR2 polypeptide, one or more fragments of HPR1 and/or HPR2 polypeptides,  
20 or any of the derivative or variant forms of HPR1 and HPR2 polypeptides as disclosed herein. In particular embodiments, the oligomers comprise soluble HPR1 and/or HPR2 polypeptides. Oligomers can be in the form of covalently linked or non-covalently-linked multimers, including dimers, trimers, or higher oligomers. In one aspect of the invention, the oligomers maintain the binding ability of the polypeptide components and provide therefor, bivalent, trivalent, etc., binding sites. In an alternative  
25 embodiment the invention is directed to oligomers comprising multiple HPR1 and/or HPR2 polypeptides joined via covalent or non-covalent interactions between peptide moieties fused to the polypeptides, such peptides having the property of promoting oligomerization. Leucine zippers and certain polypeptides derived from antibodies are among the peptides that can promote oligomerization of the polypeptides attached thereto, as described in more detail below.

In embodiments where variants of the HPR1 and/or HPR2 polypeptides are constructed to include a membrane-spanning domain, they will form a Type I membrane polypeptide. Membrane-spanning HPR1 and/or HPR2 polypeptides can be fused with extracellular domains of receptor polypeptides for which the ligand is known. Such fusion polypeptides can then be manipulated to control the intracellular signaling pathways triggered by the membrane-spanning HPR1 or HPR2  
35 polypeptide. HPR1 and HPR2 polypeptides that span the cell membrane can also be fused with agonists or antagonists of cell-surface receptors, or cellular adhesion molecules to further modulate HPR1 and/or HPR2 intracellular effects. In another aspect of the present invention, interleukins can be situated between the preferred HPR1 or HPR2 polypeptide fragment and other fusion polypeptide domains.

40 Immunoglobulin-based Oligomers. The polypeptides of the invention or fragments thereof can be fused to molecules such as immunoglobulins for many purposes, including increasing the valency of polypeptide binding sites. For example, fragments of an HPR1 polypeptide and/or of an

5 HPR2 polypeptide can be fused directly or through linker sequences to the Fc portion of an immunoglobulin. For a bivalent form of the polypeptide, such a fusion could be to the Fc portion of an IgG molecule. Other immunoglobulin isotypes can also be used to generate such fusions. For example, a polypeptide-IgM fusion would generate a decavalent form of the polypeptide of the invention. The term "Fc polypeptide" as used herein includes native and mutein forms of polypeptides made up of the Fc region of an antibody comprising any or all of the CH domains of the Fc region. Truncated forms of such polypeptides containing the hinge region that promotes dimerization are also included. Preferred Fc polypeptides comprise an Fc polypeptide derived from a human IgG1 antibody. As one alternative, an oligomer is prepared using polypeptides derived from immunoglobulins. Preparation of fusion polypeptides comprising certain heterologous polypeptides fused to various portions of antibody-derived polypeptides (including the Fc domain) has been described, *e.g.*, by Ashkenazi et al. (*PNAS USA* 88:10535, 1991); Byrn et al. (*Nature* 344:677, 1990); and Hollenbaugh and Aruffo ("Construction of Immunoglobulin Fusion Polypeptides", in *Current Protocols in Immunology*, Suppl. 4, pages 10.19.1 - 10.19.11, 1992). Methods for preparation and use of immunoglobulin-based oligomers are well known in the art. One embodiment of the present invention is directed to a dimer comprising two fusion polypeptides created by fusing a polypeptide of the invention to an Fc polypeptide derived from an antibody. A gene fusion encoding the polypeptide/Fc fusion polypeptide is inserted into an appropriate expression vector. Polypeptide/Fc fusion polypeptides are expressed in host cells transformed with the recombinant expression vector, and allowed to assemble much like antibody molecules, whereupon interchain disulfide bonds form between the Fc moieties to yield divalent molecules. One suitable Fc polypeptide, described in PCT application WO 93/10151, is a single chain polypeptide extending from the N-terminal hinge region to the native C-terminus of the Fc region of a human IgG1 antibody. Another useful Fc polypeptide is the Fc mutein described in U.S. Patent 5,457,035 and in Baum et al., (*EMBO J.* 13:3992-4001, 1994). The amino acid sequence of this mutein is identical to that of the native Fc sequence presented in WO 93/10151, except that amino acid 19 has been changed from Leu to Ala, amino acid 20 has been changed from Leu to Glu, and amino acid 22 has been changed from Gly to Ala. The mutein exhibits reduced affinity for Fc receptors. The above-described fusion polypeptides comprising Fc moieties (and oligomers formed therefrom) offer the advantage of facile purification by affinity chromatography over Polypeptide A or Polypeptide G columns. In other embodiments, the polypeptides of the invention can be substituted for the variable portion of an antibody heavy or light chain. If fusion polypeptides are made with both heavy and light chains of an antibody, it is possible to form an oligomer with as many as four HPR1 and/or HPR2 extracellular regions.

Peptide-linker Based Oligomers. Alternatively, the oligomer is a fusion polypeptide comprising multiple HPR1 and/or HPR2 polypeptides, with or without peptide linkers (spacer peptides). Among the suitable peptide linkers are those described in U.S. Patents 4,751,180 and 4,935,233. A DNA sequence encoding a desired peptide linker can be inserted between, and in the same reading frame as, the DNA sequences of the invention, using any suitable conventional technique.

5 For example, a chemically synthesized oligonucleotide encoding the linker can be ligated between the sequences. In particular embodiments, a fusion polypeptide comprises from two to four soluble HPR1 and/or HPR2 polypeptides, separated by peptide linkers. Suitable peptide linkers, their combination with other polypeptides, and their use are well known by those skilled in the art.

10 Leucine-Zippers. Another method for preparing the oligomers of the invention involves use of a leucine zipper. Leucine zipper domains are peptides that promote oligomerization of the polypeptides in which they are found. Leucine zippers were originally identified in several DNA-binding polypeptides (Landschulz et al., *Science* 240:1759, 1988), and have since been found in a variety of different polypeptides. Among the known leucine zippers are naturally occurring peptides and derivatives thereof that dimerize or trimerize. The zipper domain (also referred to herein as an  
15 oligomerizing, or oligomer-forming, domain) comprises a repetitive heptad repeat, often with four or five leucine residues interspersed with other amino acids. Use of leucine zippers and preparation of oligomers using leucine zippers are well known in the art.

Other fragments and derivatives of the sequences of polypeptides which would be expected to retain polypeptide activity in whole or in part and may thus be useful for screening or other  
20 immunological methodologies can also be made by those skilled in the art given the disclosures herein. Such modifications are believed to be encompassed by the present invention.

#### **Nucleic Acids Encoding HPR1 Polypeptides and Nucleic Acids Encoding HPR2 Polypeptides**

Encompassed within the invention are nucleic acids encoding HPR1 polypeptides and nucleic  
25 acids encoding HPR2 polypeptides. These nucleic acids can be identified in several ways, including isolation of genomic or cDNA molecules from a suitable source. Nucleotide sequences corresponding to the amino acid sequences described herein, to be used as probes or primers for the isolation of nucleic acids or as query sequences for database searches, can be obtained by "back-translation" from the amino acid sequences, or by identification of regions of amino acid identity with polypeptides for  
30 which the coding DNA sequence has been identified. The well-known polymerase chain reaction (PCR) procedure can be employed to isolate and amplify a DNA sequence encoding an HPR1 or HPR2 polypeptide or a desired combination of HPR1 and/or HPR2 polypeptide fragments. Oligonucleotides that define the desired termini of the combination of DNA fragments are employed as 5' and 3' primers. The oligonucleotides can additionally contain recognition sites for restriction endonucleases, to  
35 facilitate insertion of the amplified combination of DNA fragments into an expression vector. PCR techniques are described in Saiki et al., *Science* 239:487 (1988); *Recombinant DNA Methodology*, Wu et al., eds., Academic Press, Inc., San Diego (1989), pp. 189-196; and *PCR Protocols: A Guide to Methods and Applications*, Innis et. al., eds., Academic Press, Inc. (1990).

40 Nucleic acid molecules of the invention include DNA and RNA in both single-stranded and double-stranded form, as well as the corresponding complementary sequences. DNA includes, for example, cDNA, genomic DNA, chemically synthesized DNA, DNA amplified by PCR, and combinations thereof. The nucleic acid molecules of the invention include full-length genes or cDNA

5 molecules as well as a combination of fragments thereof. The nucleic acids of the invention are preferentially derived from human sources, but the invention includes those derived from non-human species, as well.

10 An "isolated nucleic acid" is a nucleic acid that has been separated from adjacent genetic sequences present in the genome of the organism from which the nucleic acid was isolated, in the case of nucleic acids isolated from naturally-occurring sources. In the case of nucleic acids synthesized enzymatically from a template or chemically, such as PCR products, cDNA molecules, or oligonucleotides for example, it is understood that the nucleic acids resulting from such processes are isolated nucleic acids. An isolated nucleic acid molecule refers to a nucleic acid molecule in the form of a separate fragment or as a component of a larger nucleic acid construct. In one preferred  
15 embodiment, the invention relates to certain isolated nucleic acids that are substantially free from contaminating endogenous material. The nucleic acid molecule has preferably been derived from DNA or RNA isolated at least once in substantially pure form and in a quantity or concentration enabling identification, manipulation, and recovery of its component nucleotide sequences by standard biochemical methods (such as those outlined in Sambrook et al., *Molecular Cloning: A Laboratory Manual*, 2nd ed., Cold Spring Harbor Laboratory, Cold Spring Harbor, NY (1989)). Such sequences  
20 are preferably provided and/or constructed in the form of an open reading frame uninterrupted by internal non-translated sequences, or introns, that are typically present in eukaryotic genes. Sequences of non-translated DNA can be present 5' or 3' from an open reading frame, where the same do not interfere with manipulation or expression of the coding region.

25 "An isolated nucleic acid consisting essentially of a nucleotide sequence" means that the nucleic acid may have, in addition to said nucleotide sequence, additional material covalently linked to either or both ends of the nucleic acid molecule, said additional material preferably between 1 and 100,000 additional nucleotides covalently linked to either end, each end, or both ends of the nucleic acid molecule, and more preferably between 1 and 1,000 additional nucleotides covalently linked to  
30 either end, each end, or both ends of the nucleic acid molecule, and most preferably between 10 and 100 additional nucleotides covalently linked to either end, each end, or both ends of the nucleic acid molecule. In preferred embodiments, covalent linkage of additional nucleotides to either end, each end, or both ends of the nucleic acid molecule results in a novel combined nucleotide sequence that is neither naturally occurring nor disclosed in the art. An isolated nucleic acid consisting essentially of a  
35 nucleotide sequence may be an expression vector or other construct comprising said nucleotide sequence.

The present invention also includes nucleic acids that hybridize under moderately stringent conditions, and more preferably highly stringent conditions, to nucleic acids encoding HPR1 polypeptides and/or nucleic acids encoding HPR2 polypeptides described herein. The basic parameters  
40 affecting the choice of hybridization conditions and guidance for devising suitable conditions are set forth by Sambrook, Fritsch, and Maniatis (1989, *Molecular Cloning: A Laboratory Manual*, Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y., chapters 9 and 11; and *Current Protocols*

5 in Molecular Biology, 1995, Ausubel et al., eds., John Wiley & Sons, Inc., sections 2.10 and 6.3-6.4), and can be readily determined by those having ordinary skill in the art based on, for example, the length and/or base composition of the DNA. One way of achieving moderately stringent conditions involves the use of a prewashing solution containing 5 x SSC, 0.5% SDS, 1.0 mM EDTA (pH 8.0), hybridization buffer of about 50% formamide, 6 x SSC, and a hybridization temperature of about 55  
10 degrees C (or other similar hybridization solutions, such as one containing about 50% formamide, with a hybridization temperature of about 42 degrees C), and washing conditions of about 60 degrees C, in 0.5 x SSC, 0.1% SDS. Generally, highly stringent conditions are defined as hybridization conditions as above, but with washing at approximately 68 degrees C, 0.2 x SSC, 0.1% SDS. SSPE (1xSSPE is 0.15M NaCl, 10 mM NaH.sub.2 PO.sub.4, and 1.25 mM EDTA, pH 7.4) can be substituted for SSC  
15 (1xSSC is 0.15M NaCl and 15 mM sodium citrate) in the hybridization and wash buffers; washes are performed for 15 minutes after hybridization is complete. It should be understood that the wash temperature and wash salt concentration can be adjusted as necessary to achieve a desired degree of stringency by applying the basic principles that govern hybridization reactions and duplex stability, as known to those skilled in the art and described further below (see, e.g., Sambrook et al., 1989). When  
20 hybridizing a nucleic acid to a target nucleic acid of unknown sequence, the hybrid length is assumed to be that of the hybridizing nucleic acid. When nucleic acids of known sequence are hybridized, the hybrid length can be determined by aligning the sequences of the nucleic acids and identifying the region or regions of optimal sequence complementarity. The hybridization temperature for hybrids anticipated to be less than 50 base pairs in length should be 5 to 10 degrees C less than the melting  
25 temperature (T<sub>m</sub>) of the hybrid, where T<sub>m</sub> is determined according to the following equations. For hybrids less than 18 base pairs in length, T<sub>m</sub> (degrees C) = 2(# of A + T bases) + 4(# of #G + C bases). For hybrids above 18 base pairs in length, T<sub>m</sub> (degrees C) = 81.5 + 16.6(log<sub>10</sub> [Na<sup>+</sup>]) + 0.41(% G + C) - (600/N), where N is the number of bases in the hybrid, and [Na<sup>+</sup>] is the concentration of sodium ions in the hybridization buffer ([Na<sup>+</sup>] for 1xSSC = 0.165M). Preferably, each such hybridizing nucleic acid  
30 has a length that is at least 15 nucleotides (or more preferably at least 18 nucleotides, or at least 20 nucleotides, or at least 25 nucleotides, or at least 30 nucleotides, or at least 40 nucleotides, or most preferably at least 50 nucleotides), or at least 25% (more preferably at least 50%, or at least 60%, or at least 70%, and most preferably at least 80%) of the length of the nucleic acid of the present invention to which it hybridizes, and has at least 60% sequence identity (more preferably at least 70%, at least 75%,  
35 at least 80%, at least 85%, at least 90%, at least 95%, at least 97.5%, or at least 99%, and most preferably at least 99.5%) with the nucleic acid of the present invention to which it hybridizes, where sequence identity is determined by comparing the sequences of the hybridizing nucleic acids when aligned so as to maximize overlap and identity while minimizing sequence gaps as described in more detail above.

40 The present invention also provides genes corresponding to the nucleic acid sequences disclosed herein. "Corresponding genes" or "corresponding genomic nucleic acids" are the regions of the genome that are transcribed to produce the mRNAs from which cDNA nucleic acid sequences are

5 derived and can include contiguous regions of the genome necessary for the regulated expression of such genes. Corresponding genes can therefore include but are not limited to coding sequences, 5' and 3' untranslated regions, alternatively spliced exons, introns, promoters, enhancers, and silencer or suppressor elements. Corresponding genomic nucleic acids can include 10000 basepairs (more preferably, 5000 basepairs, still more preferably, 2500 basepairs, and most preferably, 1000 basepairs) of genomic nucleic acid sequence upstream of the first nucleotide of the genomic sequence corresponding to the initiation codon of the HPR1 coding sequence or of the HPR2 coding sequence, and 10000 basepairs (more preferably, 5000 basepairs, still more preferably, 2500 basepairs, and most preferably, 1000 basepairs) of genomic nucleic acid sequence downstream of the last nucleotide of the genomic sequence corresponding to the termination codon of the HPR1 coding sequence or of the HPR2 coding sequence. The corresponding genes or genomic nucleic acids can be isolated in accordance with known methods using the sequence information disclosed herein. Such methods include the preparation of probes or primers from the disclosed sequence information for identification and/or amplification of genes in appropriate genomic libraries or other sources of genomic materials. An "isolated gene" or an "isolated genomic nucleic acid" is a genomic nucleic acid that has been separated from the adjacent genomic sequences present in the genome of the organism from which the genomic nucleic acid was isolated.

#### Methods for Making and Purifying HPR1 and HPR2 Polypeptides

Methods for making HPR1 and HPR2 polypeptides are described below. Expression, isolation, and purification of the polypeptides and fragments of the invention can be accomplished by any suitable technique, including but not limited to the following methods. The isolated nucleic acid of the invention can be operably linked to an expression control sequence such as the pDC409 vector (Giri *et al.*, 1990, *EMBO J.*, 13: 2821) or the derivative pDC412 vector (Wiley *et al.*, 1995, *Immunity* 3: 673). The pDC400 series vectors are useful for transient mammalian expression systems, such as CV-1 or 293 cells. Alternatively, the isolated nucleic acid of the invention can be linked to expression vectors such as pDC312, pDC316, or pDC317 vectors, which are useful for stable mammalian expression systems, such as CHO cells or their derivatives. Other expression control sequences and cloning technologies can also be used to produce the polypeptide recombinantly, such as the pMT2 or pED expression vectors (Kaufman *et al.*, 1991, *Nucleic Acids Res.* 19: 4485-4490; and Pouwels *et al.*, 1985, *Cloning Vectors: A Laboratory Manual*, Elsevier, New York) and the GATEWAY Vectors ([lifetech.com/Content/Tech-Online/molecular\\_biology/manuals\\_pps/11797016.pdf](http://lifetech.com/Content/Tech-Online/molecular_biology/manuals_pps/11797016.pdf); Life Technologies; Rockville, MD). Many suitable expression control sequences are known in the art. General methods of expressing recombinant polypeptides are also known and are exemplified in R. Kaufman, *Methods in Enzymology* 185, 537-566 (1990). As used herein "operably linked" means that the nucleic acid of the invention and an expression control sequence are situated within a construct, vector, or cell in such a way that the polypeptide encoded by the nucleic acid is expressed when appropriate molecules (such as polymerases) are present. As one embodiment of the invention, at least one expression control



5 sequence is operably linked to the nucleic acid of the invention in a recombinant host cell or progeny thereof, the nucleic acid and/or expression control sequence having been introduced into the host cell by transformation or transfection, for example, or by any other suitable method. As another embodiment of the invention, at least one expression control sequence is integrated into the genome of a recombinant host cell such that it is operably linked to a nucleic acid sequence encoding a polypeptide of the invention. In a further embodiment of the invention, at least one expression control sequence is operably linked to a nucleic acid of the invention through the action of a trans-acting factor such as a transcription factor, either *in vitro* or in a recombinant host cell.

In addition, a sequence encoding an appropriate signal peptide (native or heterologous) can be incorporated into expression vectors. The choice of signal peptide or leader can depend on factors such as the type of host cells in which the recombinant polypeptide is to be produced. To illustrate, examples of heterologous signal peptides that are functional in mammalian host cells include the signal sequence for interleukin-7 (IL-7) described in United States Patent 4,965,195; the signal sequence for interleukin-2 receptor described in Cosman et al., *Nature* 312:768 (1984); the interleukin-4 receptor signal peptide described in EP 367,566; the type I interleukin-1 receptor signal peptide described in U.S. Patent 4,968,607; and the type II interleukin-1 receptor signal peptide described in EP 460,846. A DNA sequence for a signal peptide (secretory leader) can be fused in frame to the nucleic acid sequence of the invention so that the DNA is initially transcribed, and the mRNA translated, into a fusion polypeptide comprising the signal peptide. A signal peptide that is functional in the intended host cells promotes extracellular secretion of the polypeptide. The signal peptide is cleaved from the polypeptide upon secretion of polypeptide from the cell. The skilled artisan will also recognize that the position(s) at which the signal peptide is cleaved can differ from that predicted by computer program, and can vary according to such factors as the type of host cells employed in expressing a recombinant polypeptide. A polypeptide preparation can include a mixture of polypeptide molecules having different N-terminal amino acids, resulting from cleavage of the signal peptide at more than one site.

Established methods for introducing DNA into mammalian cells have been described (Kaufman, R.J., *Large Scale Mammalian Cell Culture*, 1990, pp. 15-69). Additional protocols using commercially available reagents, such as Lipofectamine lipid reagent (Gibco/BRL) or Lipofectamine-Plus lipid reagent, can be used to transfect cells (Felgner et al., *Proc. Natl. Acad. Sci. USA* 84:7413-7417, 1987). In addition, electroporation can be used to transfect mammalian cells using conventional procedures, such as those in Sambrook et al. (*Molecular Cloning: A Laboratory Manual*, 2 ed. Vol. 1-3, Cold Spring Harbor Laboratory Press, 1989). Selection of stable transformants can be performed using methods known in the art, such as, for example, resistance to cytotoxic drugs. Kaufman et al., *Meth. in Enzymology* 185:487-511, 1990, describes several selection schemes, such as dihydrofolate reductase (DHFR) resistance. A suitable strain for DHFR selection can be CHO strain DX-B11, which is deficient in DHFR (Urlaub and Chasin, *Proc. Natl. Acad. Sci. USA* 77:4216-4220, 1980). Other examples of selectable markers that can be incorporated into an expression vector include cDNAs

5 conferring resistance to antibiotics, such as G418 and hygromycin B. Cells harboring the vector can be selected on the basis of resistance to these compounds.

Alternatively, gene products can be obtained via homologous recombination, or "gene targeting," techniques. Such techniques employ the introduction of exogenous transcription control elements (such as the CMV promoter or the like) in a particular predetermined site on the genome, to  
10 induce expression of the endogenous nucleic acid sequence of interest (see, for example, U.S. Patent No. 5,272,071). The location of integration into a host chromosome or genome can be easily determined by one of skill in the art, given the known location and sequence of the gene. In a preferred embodiment, the present invention also contemplates the introduction of exogenous transcriptional control elements in conjunction with an amplifiable gene, to produce increased amounts of the gene  
15 product, again, without the need for isolation of the gene sequence itself from the host cell.

A number of types of cells can act as suitable host cells for expression of the polypeptide. Mammalian host cells include, for example, the COS-7 line of monkey kidney cells (ATCC CRL 1651) (Gluzman et al., *Cell* 23:175, 1981), L cells, C127 cells, 3T3 cells (ATCC CCL 163), Chinese hamster ovary (CHO) cells, HeLa cells, BHK (ATCC CRL 10) cell lines, the CV1/EBNA cell line derived from  
20 the African green monkey kidney cell line CV1 (ATCC CCL 70) as described by McMahan et al. (*EMBO J.* 10: 2821, 1991), human kidney 293 cells, human epidermal A431 cells, human Colo205 cells, other transformed primate cell lines, normal diploid cells, cell strains derived from in vitro culture of primary tissue, primary explants, HL-60, U937, HaK or Jurkat cells. Alternatively, it is possible to produce the polypeptide in lower eukaryotes such as yeast or in prokaryotes such as bacteria.  
25 Potentially suitable yeasts include *Saccharomyces cerevisiae*, *Schizosaccharomyces pombe*, *Kluyveromyces* strains, *Candida*, or any yeast strain capable of expressing heterologous polypeptides. Potentially suitable bacterial strains include *Escherichia coli*, *Bacillus subtilis*, *Salmonella typhimurium*, or any bacterial strain capable of expressing heterologous polypeptides. If the polypeptide is made in yeast or bacteria, it may be necessary to modify the polypeptide produced therein, for example by phosphorylation or glycosylation of the appropriate sites, in order to obtain the  
30 functional polypeptide. Such covalent attachments can be accomplished using known chemical or enzymatic methods. The polypeptide can also be produced by operably linking the isolated nucleic acid of the invention to suitable control sequences in one or more insect expression vectors, and employing an insect expression system. Materials and methods for baculovirus/insect cell expression systems are commercially available in kit form from, e.g., Invitrogen, San Diego, Calif., U.S.A. (the  
35 MaxBac® kit), and such methods are well known in the art, as described in Summers and Smith, Texas Agricultural Experiment Station Bulletin No. 1555 (1987), and Luckow and Summers, *Bio/Technology* 6:47 (1988). Cell-free translation systems could also be employed to produce polypeptides using RNAs derived from nucleic acid constructs disclosed herein. A host cell that comprises an isolated  
40 nucleic acid of the invention, preferably operably linked to at least one expression control sequence, is a "recombinant host cell".

5           The polypeptide of the invention can be prepared by culturing transformed host cells under culture conditions suitable to express the recombinant polypeptide. The resulting expressed polypeptide can then be purified from such culture (i.e., from culture medium or cell extracts) using known purification processes, such as gel filtration and ion exchange chromatography. The purification of the polypeptide can also include an affinity column containing agents which will bind to the polypeptide; one or more column steps over such affinity resins as concanavalin A-agarose, heparin-  
10           toyopearl® or Cibacrom blue 3GA Sepharose®; one or more steps involving hydrophobic interaction chromatography using such resins as phenyl ether, butyl ether, or propyl ether; or immunoaffinity chromatography. Alternatively, the polypeptide of the invention can also be expressed in a form which will facilitate purification. For example, it can be expressed as a fusion polypeptide, such as those of  
15           maltose binding polypeptide (MBP), glutathione-S-transferase (GST) or thioredoxin (TRX). Kits for expression and purification of such fusion polypeptides are commercially available from New England BioLab (Beverly, Mass.), Pharmacia (Piscataway, N.J.) and InVitrogen, respectively. The polypeptide can also be tagged with an epitope and subsequently purified by using a specific antibody directed to such epitope. One such epitope (FLAG®) is commercially available from Kodak (New Haven, Conn.).  
20           Finally, one or more reverse-phase high performance liquid chromatography (RP-HPLC) steps employing hydrophobic RP-HPLC media, e.g., silica gel having pendant methyl or other aliphatic groups, can be employed to further purify the polypeptide. Some or all of the foregoing purification steps, in various combinations, can also be employed to provide a substantially homogeneous isolated recombinant polypeptide. The polypeptide thus purified is substantially free of other mammalian  
25           polypeptides and is defined in accordance with the present invention as an "isolated polypeptide"; such isolated polypeptides of the invention include isolated antibodies that bind to HPR1 and/or HPR2 polypeptides, fragments, variants, binding partners etc. The polypeptide of the invention can also be expressed as a product of transgenic animals, e.g., as a component of the milk of transgenic cows, goats, pigs, or sheep which are characterized by somatic or germ cells containing a nucleotide sequence  
30           encoding the polypeptide.

          It is also possible to utilize an affinity column comprising a polypeptide-binding polypeptide of the invention, such as a monoclonal antibody generated against polypeptides of the invention, to affinity-purify expressed polypeptides. These polypeptides can be removed from an affinity column using conventional techniques, e.g., in a high salt elution buffer and then dialyzed into a lower salt  
35           buffer for use or by changing pH or other components depending on the affinity matrix utilized, or be competitively removed using the naturally occurring substrate of the affinity moiety, such as a polypeptide derived from the invention. In this aspect of the invention, polypeptide-binding polypeptides, such as the anti-polypeptide antibodies of the invention or other polypeptides that can interact with the polypeptide of the invention, can be bound to a solid phase support such as a column  
40           chromatography matrix or a similar substrate suitable for identifying, separating, or purifying cells that express polypeptides of the invention on their surface. Adherence of polypeptide-binding polypeptides of the invention to a solid phase contacting surface can be accomplished by any means, for example,

5 magnetic microspheres can be coated with these polypeptide-binding polypeptides and held in the incubation vessel through a magnetic field. Suspensions of cell mixtures are contacted with the solid phase that has such polypeptide-binding polypeptides thereon. Cells having polypeptides of the invention on their surface bind to the fixed polypeptide-binding polypeptide and unbound cells then are washed away. This affinity-binding method is useful for purifying, screening, or separating such  
10 polypeptide-expressing cells from solution. Methods of releasing positively selected cells from the solid phase are known in the art and encompass, for example, the use of enzymes. Such enzymes are preferably non-toxic and non-injurious to the cells and are preferably directed to cleaving the cell-surface binding partner. Alternatively, mixtures of cells suspected of containing polypeptide-expressing cells of the invention first can be incubated with a biotinylated polypeptide-binding  
15 polypeptide of the invention. The resulting mixture then is passed through a column packed with avidin-coated beads, whereby the high affinity of biotin for avidin provides the binding of the polypeptide-binding cells to the beads. Use of avidin-coated beads is known in the art. See Berenson, et al. *J. Cell. Biochem.*, 10D:239 (1986). Wash of unbound material and the release of the bound cells is performed using conventional methods.

20 The polypeptide can also be produced by known conventional chemical synthesis. The synthetically-constructed polypeptide sequences, by virtue of sharing primary, secondary or tertiary structural and/or conformational characteristics with HPR1 and/or HPR2 polypeptides can possess biological properties in common therewith, including HPR1 and/or HPR2 polypeptide activity. Thus, they can be employed as biologically active or immunological substitutes for natural, purified  
25 polypeptides in screening of therapeutic compounds and in immunological processes for the development of antibodies.

The desired degree of purity depends on the intended use of the polypeptide. A relatively high degree of purity is desired when the polypeptide is to be administered *in vivo*, for example. In such a case, the polypeptides are purified such that no polypeptide bands corresponding to other polypeptides  
30 are detectable upon analysis by SDS-polyacrylamide gel electrophoresis (SDS-PAGE). It will be recognized by one skilled in the pertinent field that multiple bands corresponding to the polypeptide can be visualized by SDS-PAGE, due to differential glycosylation, differential post-translational processing, and the like. Most preferably, the polypeptide of the invention is purified to substantial homogeneity, as indicated by a single polypeptide band upon analysis by SDS-PAGE. The polypeptide  
35 band can be visualized by silver staining, Coomassie blue staining, or (if the polypeptide is radiolabeled) by autoradiography.

#### **Antagonists and Agonists of HPR1 and/or HPR2 Polypeptides**

Any method which neutralizes HPR1 and/or HPR2 polypeptides or inhibits expression of the HPR1 and/or HPR2 genes (either transcription or translation) can be used to reduce the biological  
40 activities of HPR1 and/or HPR2 polypeptides. In particular embodiments, antagonists inhibit the binding of at least one HPR1 polypeptide and/or at least one HPR2 polypeptide to cells, thereby inhibiting biological activities induced by the binding of those HPR1 or HPR2 polypeptides to the

5 cells. In certain other embodiments of the invention, antagonists can be designed to reduce the level of endogenous HPR1 and/or HPR2 gene expression, *e.g.*, using well-known antisense or ribozyme approaches to inhibit or prevent translation of HPR1 and/or HPR2 mRNA transcripts; triple helix approaches to inhibit transcription of HPR1 and/or HPR2 genes; or targeted homologous recombination to inactivate or "knock out" the HPR1 gene(s), the HPR2 gene(s), or their endogenous  
10 promoters or enhancer elements. Such antisense, ribozyme, and triple helix antagonists can be designed to reduce or inhibit either unimpaired, or if appropriate, mutant HPR1 and/or HPR2 gene activity. Techniques for the production and use of such molecules are well known to those of skill in the art.

Antisense RNA and DNA molecules act to directly block the translation of mRNA by  
15 hybridizing to targeted mRNA and preventing polypeptide translation. Antisense approaches involve the design of oligonucleotides (either DNA or RNA) that are complementary to an HPR1 and/or to an HPR2 mRNA. The antisense oligonucleotides will bind to the complementary target gene mRNA transcripts and prevent translation. Absolute complementarity, although preferred, is not required. A sequence "complementary" to a portion of a nucleic acid, as referred to herein, means a sequence  
20 having sufficient complementarity to be able to hybridize with the nucleic acid, forming a stable duplex (or triplex, as appropriate). In the case of double-stranded antisense nucleic acids, a single strand of the duplex DNA can thus be tested, or triplex formation can be assayed. The ability to hybridize will depend on both the degree of complementarity and the length of the antisense nucleic acid. Preferred oligonucleotides are complementary to the 5' end of the message, *e.g.*, the 5' untranslated sequence up  
25 to and including the AUG initiation codon. However, oligonucleotides complementary to the 5'- or 3'-non-translated, non-coding regions of the HPR1 or HPR2 gene transcript(s) could be used in an antisense approach to inhibit translation of endogenous HPR1 and/or HPR2 mRNA. Antisense nucleic acids should be at least six nucleotides in length, and are preferably oligonucleotides ranging from 6 to about 50 nucleotides in length. In specific aspects the oligonucleotide is at least 10 nucleotides, at least  
30 17 nucleotides, at least 25 nucleotides or at least 50 nucleotides. The oligonucleotides can be DNA or RNA or chimeric mixtures or derivatives or modified versions thereof, single-stranded or double-stranded. Chimeric oligonucleotides, oligonucleosides, or mixed oligonucleotides/oligonucleosides of the invention can be of several different types. These include a first type wherein the "gap" segment of nucleotides is positioned between 5' and 3' "wing" segments of linked nucleosides and a second "open  
35 end" type wherein the "gap" segment is located at either the 3' or the 5' terminus of the oligomeric compound (*see, e.g.*, U.S. Pat. No. 5,985,664). Oligonucleotides of the first type are also known in the art as "gapmers" or gapped oligonucleotides. Oligonucleotides of the second type are also known in the art as "hemimers" or "wingmers". The oligonucleotide can be modified at the base moiety, sugar moiety, or phosphate backbone, for example, to improve stability of the molecule, hybridization, etc.  
40 The oligonucleotide can include other appended groups such as peptides (*e.g.*, for targeting host cell receptors *in vivo*), or agents facilitating transport across the cell membrane (*see, e.g.*, Letsinger *et al.*, 1989, *Proc Natl Acad Sci USA* 86:6553-6556; Lemaitre *et al.*, 1987, *Proc Natl Acad Sci* 84:648-652;

5 PCT Publication No. WO88/09810), or hybridization-triggered cleavage agents or intercalating agents. (See, *e.g.*, Zon, 1988, Pharm. Res. 5:539-549). The antisense molecules should be delivered to cells which express the HPR1 and/or HPR2 transcript in vivo. A number of methods have been developed for delivering antisense DNA or RNA to cells; *e.g.*, antisense molecules can be injected directly into the tissue or cell derivation site, or modified antisense molecules, designed to target the desired cells  
10 (*e.g.*, antisense linked to peptides or antibodies that specifically bind receptors or antigens expressed on the target cell surface) can be administered systemically. However, it is often difficult to achieve intracellular concentrations of the antisense sufficient to suppress translation of endogenous mRNAs. Therefore a preferred approach utilizes a recombinant DNA construct in which the antisense oligonucleotide is placed under the control of a strong pol III or pol II promoter. The use of such a  
15 construct to transfect target cells in the patient will result in the transcription of sufficient amounts of single stranded RNAs that will form complementary base pairs with the endogenous HPR1 and/or HPR2 gene transcripts and thereby prevent translation of the HPR1 and/or HPR2 mRNA. For example, a vector can be introduced in vivo such that it is taken up by a cell and directs the transcription of an antisense RNA. Such a vector can remain episomal or become chromosomally  
20 integrated, as long as it can be transcribed to produce the desired antisense RNA. Such vectors can be constructed by recombinant DNA technology methods standard in the art. Vectors can be plasmid, viral, or others known in the art, used for replication and expression in mammalian cells.

Ribozyme molecules designed to catalytically cleave HPR1 and/or HPR2 mRNA transcripts can also be used to prevent translation of HPR1 and/or HPR2 mRNA and expression of HPR1 and/or  
25 HPR2 polypeptides. (See, *e.g.*, PCT International Publication WO90/11364 and US Patent No. 5,824,519). The ribozymes that can be used in the present invention include hammerhead ribozymes (Haseloff and Gerlach, 1988, Nature, 334:585-591), RNA endoribonucleases (hereinafter "Cech-type ribozymes") such as the one which occurs naturally in Tetrahymena Thermophila (known as the IVS, or L-19 IVS RNA) and which has been extensively described by Thomas Cech and collaborators  
30 (International Patent Application No. WO 88/04300; Been and Cech, 1986, Cell, 47:207-216). As in the antisense approach, the ribozymes can be composed of modified oligonucleotides (*e.g.* for improved stability, targeting, etc.) and should be delivered to cells which express HPR1 and/or HPR2 polypeptides in vivo. A preferred method of delivery involves using a DNA construct "encoding" the ribozyme under the control of a strong constitutive pol III or pol II promoter, so that transfected cells  
35 will produce sufficient quantities of the ribozyme to destroy endogenous HPR1 and/or HPR2 messages and inhibit translation. Because ribozymes, unlike antisense molecules, are catalytic, a lower intracellular concentration is required for efficiency.

Alternatively, endogenous HPR1 and/or HPR2 gene expression can be reduced by targeting deoxyribonucleotide sequences complementary to the regulatory region of the target gene (*i.e.*, the  
40 target gene promoter and/or enhancers) to form triple helical structures that prevent transcription of the target HPR1 and/or HPR2 gene. (See generally, Helene, 1991, Anticancer Drug Des., 6(6), 569-584; Helene, et al., 1992, Ann. N.Y. Acad. Sci., 660, 27-36; and Maher, 1992, Bioassays 14(12), 807-815).

5           Anti-sense RNA and DNA, ribozyme, and triple helix molecules of the invention can be prepared by any method known in the art for the synthesis of DNA and RNA molecules. These include techniques for chemically synthesizing oligodeoxyribonucleotides and oligoribonucleotides well known in the art such as for example solid phase phosphoramidite chemical synthesis. Oligonucleotides can be synthesized by standard methods known in the art, *e.g.* by use of an automated  
10 DNA synthesizer (such as are commercially available from Biosearch, Applied Biosystems, etc.). As examples, phosphorothioate oligonucleotides can be synthesized by the method of Stein *et al.*, 1988, Nucl. Acids Res. 16:3209. Methylphosphonate oligonucleotides can be prepared by use of controlled pore glass polymer supports (Sarin *et al.*, 1988, Proc. Natl. Acad. Sci. U.S.A. 85:7448-7451). Alternatively, RNA molecules can be generated by in vitro and in vivo transcription of DNA sequences  
15 encoding the antisense RNA molecule. Such DNA sequences can be incorporated into a wide variety of vectors that incorporate suitable RNA polymerase promoters such as the T7 or SP6 polymerase promoters. Alternatively, antisense cDNA constructs that synthesize antisense RNA constitutively or inducibly, depending on the promoter used, can be introduced stably into cell lines.

          Endogenous target gene expression can also be reduced by inactivating or "knocking out" the  
20 target gene or its promoter using targeted homologous recombination (*e.g.*, see Smithies, et al., 1985, Nature 317, 230-234; Thomas and Capecchi, 1987, Cell 51, 503-512; Thompson, et al., 1989, Cell 5, 313-321). For example, a mutant, non-functional target gene (or a completely unrelated DNA sequence) flanked by DNA homologous to the endogenous target gene (either the coding regions or regulatory regions of the target gene) can be used, with or without a selectable marker and/or a negative  
25 selectable marker, to transfect cells that express the target gene in vivo. Insertion of the DNA construct, via targeted homologous recombination, results in inactivation of the target gene. Such approaches are particularly suited in the agricultural field where modifications to ES (embryonic stem) cells can be used to generate animal offspring with an inactive target gene (*e.g.*, see Thomas and Capecchi, 1987 and Thompson, 1989, *supra*), or in model organisms such as *Caenorhabditis elegans* where the "RNA interference" ("RNAi") technique (Grishok, Tabara, and Mello, 2000, Genetic requirements for inheritance of RNAi in *C. elegans*, Science 287 (5462): 2494-2497), or the introduction of transgenes (Dernburg *et al.*, 2000, Transgene-mediated cosuppression in the *C. elegans* germ line, Genes Dev. 14 (13): 1578-1583) are used to inhibit the expression of specific target genes. However this approach can be adapted for use in humans provided the recombinant DNA constructs  
30 are directly administered or targeted to the required site in vivo using appropriate vectors such as viral vectors.

          Organisms that have enhanced, reduced, or modified expression of the gene(s) corresponding to the nucleic acid sequences disclosed herein are provided. The desired change in gene expression can be achieved through the use of antisense nucleic acids or ribozymes that bind and/or cleave the mRNA  
40 transcribed from the gene (Albert and Morris, 1994, Trends Pharmacol. Sci. 15(7): 250-254; Lavarosky et al., 1997, Biochem. Mol. Med. 62(1): 11-22; and Hampel, 1998, Prog. Nucleic Acid Res. Mol. Biol. 58: 1-39). Transgenic animals that have multiple copies of the gene(s) corresponding to the nucleic

5 acid sequences disclosed herein, preferably produced by transformation of cells with genetic constructs that are stably maintained within the transformed cells and their progeny, are provided. Transgenic animals that have modified genetic control regions that increase or reduce gene expression levels, or that change temporal or spatial patterns of gene expression, are also provided (see European Patent No. 0 649 464 B1). In addition, organisms are provided in which the gene(s) corresponding to the nucleic acid sequences disclosed herein have been partially or completely inactivated, through insertion of extraneous sequences into the corresponding gene(s) or through deletion of all or part of the corresponding gene(s). Partial or complete gene inactivation can be accomplished through insertion, preferably followed by imprecise excision, of transposable elements (Plasterk, 1992, *Bioessays* 14(9): 629-633; Zwaal et al., 1993, *Proc Natl Acad Sci USA* 90(16): 7431-7435; Clark et al., 1994, *Proc Natl Acad Sci USA* 91(2): 719-722), or through homologous recombination, preferably detected by positive/negative genetic selection strategies (Mansour et al., 1988, *Nature* 336: 348-352; U.S. Pat. Nos. 5,464,764; 5,487,992; 5,627,059; 5,631,153; 5,614,396; 5,616,491; and 5,679,523). These organisms with altered gene expression are preferably eukaryotes and more preferably are mammals. Such organisms are useful for the development of non-human models for the study of disorders involving the corresponding gene(s), and for the development of assay systems for the identification of molecules that interact with the polypeptide product(s) of the corresponding gene(s).

Also encompassed within the invention are HPR1 and HPR2 polypeptide variants with partner binding sites that have been altered in conformation so that (1) the HPR1 or HPR2 variant will still bind to its partner(s), but a specified small molecule will fit into the altered binding site and block that interaction, or (2) the HPR1 or HPR2 variant will no longer bind to its partner(s) unless a specified small molecule is present (see for example Bishop *et al.*, 2000, *Nature* 407: 395-401). Nucleic acids encoding such altered HPR1 or HPR2 polypeptides can be introduced into organisms according to methods described herein, and can replace the endogenous nucleic acid sequences encoding the corresponding HPR1 or HPR2 polypeptide. Such methods allow for the interaction of a particular HPR1 or HPR2 polypeptide with its binding partners to be regulated by administration of a small molecule compound to an organism, either systemically or in a localized manner.

The HPR1 and HPR2 polypeptides themselves can also be employed in inhibiting a biological activity of HPR1 and /or of HPR2 in *in vitro* or *in vivo* procedures. Encompassed within the invention are cytokine receptor domains of HPR1 and HPR2 polypeptides that act as "dominant negative" inhibitors of native HPR1 and/or HPR2 polypeptide function when expressed as fragments or as components of fusion polypeptides. For example, a purified polypeptide domain of the present invention can be used to inhibit binding of HPR1 or HPR2 polypeptides to endogenous binding partners. Such use effectively would block HPR1 and/or HPR2 polypeptide interactions and inhibit HPR1 and/or HPR2 polypeptide activities. In still another aspect of the invention, a soluble form of an HPR1 and/or HPR2 binding partner is used to bind to an endogenous HPR1 and/or HPR2 polypeptide, and competitively inhibit activation of that endogenous HPR1 and/or HPR2 polypeptide. Furthermore, antibodies which bind to HPR1 and/or HPR2 polypeptides often inhibit HPR1 and/or HPR2



5 polypeptide activity and act as antagonists. For example, antibodies that specifically recognize one or more epitopes of HPR1 and/or HPR2 polypeptides, or epitopes of conserved variants of HPR1 and/or HPR2 polypeptides, or peptide fragments of an HPR1 and/or HPR2 polypeptide can be used in the invention to inhibit HPR1 and/or HPR2 polypeptide activity. Such antibodies include but are not limited to polyclonal antibodies, monoclonal antibodies (mAbs), humanized or chimeric antibodies, 10 single chain antibodies, Fab fragments, F(ab')<sub>2</sub> fragments, fragments produced by a Fab expression library, anti-idiotypic (anti-Id) antibodies, and epitope-binding fragments of any of the above. Alternatively, purified and modified HPR1 and/or HPR2 polypeptides of the present invention can be administered to modulate interactions between HPR1 and/or HPR2 polypeptides and HPR1 and/or HPR2 binding partners that are not membrane-bound. Such an approach will allow an alternative 15 method for the modification of HPR1- and/or HPR2-influenced bioactivity.

In an alternative aspect, the invention further encompasses the use of agonists of HPR1 and/or HPR2 polypeptide activity to treat or ameliorate the symptoms of a disease for which increased HPR1 and/or HPR2 polypeptide activity is beneficial. Such diseases include but are not limited to pancytopenia, leukopenia, anemia, thrombocytopenia, neurodegenerative disorders, osteoporosis 20 resulting from a lack of bone-forming cells, obesity, deficient mammary development, and infertility. In a preferred aspect, the invention entails administering compositions comprising an HPR1 or HPR2 nucleic acid or an HPR1 or HPR2 polypeptide to cells *in vitro*, to cells *ex vivo*, to cells *in vivo*, and/or to a multicellular organism such as a vertebrate or mammal. Preferred therapeutic forms of HPR1 and HPR2 are soluble forms, as described above. In still another aspect of the invention, the compositions 25 comprise administering an HPR1-encoding nucleic acid or an HPR2-encoding nucleic acid for expression of an HPR1 or HPR2 polypeptide in a host organism for treatment of disease. Particularly preferred in this regard is expression in a human patient for treatment of a dysfunction associated with aberrant (*e.g.*, decreased) endogenous activity of an HPR1 or HPR2 polypeptide. Furthermore, the invention encompasses the administration to cells and/or organisms of compounds found to increase 30 the endogenous activity of HPR1 and/or HPR2 polypeptides. One example of compounds that increase HPR1 and/or HPR2 polypeptide activity are agonistic antibodies, preferably monoclonal antibodies, that bind to HPR1 and/or HPR2 polypeptides or binding partners, which may increase HPR1 and/or HPR2 polypeptide activity by causing constitutive intracellular signaling (or "ligand mimicking"), or by preventing the binding of a native inhibitor of HPR1 and/or HPR2 polypeptide activity.

### 35 **Antibodies to HPR1 and/or HPR2 Polypeptides**

Antibodies that are immunoreactive with the polypeptides of the invention are provided herein. Such antibodies specifically bind to the polypeptides via the antigen-binding sites of the antibody (as opposed to non-specific binding). In the present invention, specifically binding antibodies 40 are those that will specifically recognize and bind with HPR1 and/or HPR2 polypeptides, homologues, and variants, but not with other molecules. In one preferred embodiment, the antibodies are specific for

5 the polypeptides of the present invention and do not cross-react with other polypeptides. In this manner, the HPR1 and HPR2 polypeptides, fragments, variants, fusion polypeptides, etc., as set forth above can be employed as "immunogens" in producing antibodies immunoreactive therewith.

More specifically, the polypeptides, fragment, variants, fusion polypeptides, etc. contain antigenic determinants or epitopes that elicit the formation of antibodies. These antigenic determinants  
10 or epitopes can be either linear or conformational (discontinuous). Linear epitopes are composed of a single section of amino acids of the polypeptide, while conformational or discontinuous epitopes are composed of amino acids sections from different regions of the polypeptide chain that are brought into close proximity upon polypeptide folding (Janeway and Travers, *Immuno Biology* 3:9 (Garland Publishing Inc., 2nd ed. 1996)). Because folded polypeptides have complex surfaces, the number of  
15 epitopes available is quite numerous; however, due to the conformation of the polypeptide and steric hinderances, the number of antibodies that actually bind to the epitopes is less than the number of available epitopes (Janeway and Travers, *Immuno Biology* 2:14 (Garland Publishing Inc., 2nd ed. 1996)). Epitopes can be identified by any of the methods known in the art. Thus, one aspect of the present invention relates to the antigenic epitopes of the polypeptides of the invention. Such epitopes  
20 are useful for raising antibodies, in particular monoclonal antibodies, as described in more detail below. Additionally, epitopes from the polypeptides of the invention can be used as research reagents, in assays, and to purify specific binding antibodies from substances such as polyclonal sera or supernatants from cultured hybridomas. Such epitopes or variants thereof can be produced using techniques well known in the art such as solid-phase synthesis, chemical or enzymatic cleavage of a  
25 polypeptide, or using recombinant DNA technology.

As to the antibodies that can be elicited by the epitopes of the polypeptides of the invention, whether the epitopes have been isolated or remain part of the polypeptides, both polyclonal and monoclonal antibodies can be prepared by conventional techniques. See, for example, *Monoclonal Antibodies, Hybridomas: A New Dimension in Biological Analyses*, Kennet et al. (eds.), Plenum Press,  
30 New York (1980); and *Antibodies: A Laboratory Manual*, Harlow and Land (eds.), Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY, (1988); Kohler and Milstein, (U.S. Pat. No. 4,376,110); the human B-cell hybridoma technique (Kosbor *et al.*, 1984, *J Immunol* 133: 3001-3005; Cole *et al.*, 1983, *Proc Natl Acad Sci USA* 80:2026-2030); and the EBV-hybridoma technique (Cole *et al.*, 1985, *Monoclonal Antibodies And Cancer Therapy*, Alan R. Liss, Inc., pp. 77-96). Hybridoma cell  
35 lines that produce monoclonal antibodies specific for the polypeptides of the invention are also contemplated herein. Such hybridomas can be produced and identified by conventional techniques. The hybridoma producing the mAb of this invention can be cultivated in vitro or in vivo. Production of high titers of mAbs in vivo makes this the presently preferred method of production. One method for producing such a hybridoma cell line comprises immunizing an animal with a polypeptide; harvesting  
40 spleen cells from the immunized animal; fusing said spleen cells to a myeloma cell line, thereby generating hybridoma cells; and identifying a hybridoma cell line that produces a monoclonal antibody that binds the polypeptide. For the production of antibodies, various host animals can be immunized by

5 injection with one or more of the following: an HPR1 or HPR2 polypeptide, a fragment of an HPR1 or HPR2 polypeptide, a functional equivalent of an HPR1 or HPR2 polypeptide, or a mutant form of an HPR1 or HPR2 polypeptide. Such host animals can include but are not limited to rabbits, mice, and rats. Various adjuvants can be used to increase the immunologic response, depending on the host species, including but not limited to Freund's (complete and incomplete), mineral gels such as  
10 aluminum hydroxide, surface active substances such as lysolecithin, pluronic polyols, polyanions, peptides, oil emulsions, keyhole limpet hemocyanin, dinitrophenol, and potentially useful human adjuvants such as BCG (bacille Calmette-Guerin) and *Corynebacterium parvum*. The monoclonal antibodies can be recovered by conventional techniques. Such monoclonal antibodies can be of any immunoglobulin class including IgG, IgM, IgE, IgA, IgD and any subclass thereof.

15 In addition, techniques developed for the production of "chimeric antibodies" (Takeda *et al.*, 1985, *Nature*, 314: 452-454; Morrison *et al.*, 1984, *Proc Natl Acad Sci USA* 81: 6851-6855; Boulianne *et al.*, 1984, *Nature* 312: 643-646; Neuberger *et al.*, 1985, *Nature* 314: 268-270) by splicing the genes from a mouse antibody molecule of appropriate antigen specificity together with genes from a human antibody molecule of appropriate biological activity can be used. A chimeric antibody is a molecule in  
20 which different portions are derived from different animal species, such as those having a variable region derived from a porcine mAb and a human immunoglobulin constant region. The monoclonal antibodies of the present invention also include humanized versions of murine monoclonal antibodies. Such humanized antibodies can be prepared by known techniques and offer the advantage of reduced immunogenicity when the antibodies are administered to humans. In one embodiment, a humanized  
25 monoclonal antibody comprises the variable region of a murine antibody (or just the antigen binding site thereof) and a constant region derived from a human antibody. Alternatively, a humanized antibody fragment can comprise the antigen binding site of a murine monoclonal antibody and a variable region fragment (lacking the antigen-binding site) derived from a human antibody. Procedures for the production of chimeric and further engineered monoclonal antibodies include those described in  
30 Riechmann *et al.* (*Nature* 332:323, 1988), Liu *et al.* (*PNAS* 84:3439, 1987), Larrick *et al.* (*Bio/Technology* 7:934, 1989), and Winter and Harris (*TIPS* 14:139, Can, 1993). Useful techniques for humanizing antibodies are also discussed in U.S. Patent 6,054,297. Procedures to generate antibodies transgenically can be found in GB 2,272,440, US Patent Nos. 5,569,825 and 5,545,806, and related patents. Preferably, for use in humans, the antibodies are human or humanized; techniques for creating  
35 such human or humanized antibodies are also well known and are commercially available from, for example, Medarex Inc. (Princeton, NJ) and Abgenix Inc. (Fremont, CA). In another preferred embodiment, fully human antibodies for use in humans are produced by screening a phage display library of human antibody variable domains (Vaughan *et al.*, 1998, *Nat Biotechnol.* 16(6): 535-539; and U.S. Patent No. 5,969,108).

40 Antigen-binding antibody fragments which recognize specific epitopes can be generated by known techniques. For example, such fragments include but are not limited to: the F(ab')<sub>2</sub> fragments which can be produced by pepsin digestion of the antibody molecule and the Fab fragments which can

5 be generated by reducing the disulfide bridges of the (ab')<sub>2</sub> fragments. Alternatively, Fab expression libraries can be constructed (Huse *et al.*, 1989, *Science*, 246:1275-1281) to allow rapid and easy identification of monoclonal Fab fragments with the desired specificity. Techniques described for the production of single chain antibodies (U.S. Pat. No. 4,946,778; Bird, 1988, *Science* 242:423-426; Huston *et al.*, 1988, *Proc. Natl. Acad. Sci. USA* 85:5879-5883; and Ward *et al.*, 1989, *Nature* 334:544-10 546) can also be adapted to produce single chain antibodies against HPR1 and/or HPR2 gene products. Single chain antibodies are formed by linking the heavy and light chain fragments of the Fv region via an amino acid bridge, resulting in a single chain polypeptide. Such single chain antibodies can also be useful intracellularly (i.e., as 'intrabodies'), for example as described by Marasco *et al.* (*J. Immunol. Methods* 231:223-238, 1999) for genetic therapy in HIV infection. In addition, antibodies to the HPR1 and/or HPR2 polypeptide can, in turn, be utilized to generate anti-idiotypic antibodies that "mimic" the HPR1 and/or HPR2 polypeptide and that may bind to the binding partner(s) of HPR1 and/or HPR2 polypeptides, using techniques well known to those skilled in the art. (See, *e.g.*, Greenspan & Bona, 15 1993, *FASEB J* 7(5):437-444; and Nissinoff, 1991, *J. Immunol.* 147(8):2429-2438).

Antibodies that are immunoreactive with the polypeptides of the invention include bispecific 20 antibodies (i.e., antibodies that are immunoreactive with the polypeptides of the invention via a first antigen binding domain, and also immunoreactive with a different polypeptide via a second antigen binding domain). A variety of bispecific antibodies have been prepared, and found useful both *in vitro* and *in vivo* (see, for example, U.S. Patent 5,807,706; and Cao and Suresh, 1998, *Bioconjugate Chem* 9: 635-644). Numerous methods of preparing bispecific antibodies are known in the art, including the use 25 of hybrid-hybridomas such as quadromas, which are formed by fusing two differed hybridomas, and triomas, which are formed by fusing a hybridoma with a lymphocyte (Milstein and Cuello, 1983, *Nature* 305: 537-540; U.S. Patent 4,474,893; and U.S. Patent 6,106,833). U.S. Patent 6,060,285 discloses a process for the production of bispecific antibodies in which at least the genes for the light chain and the variable portion of the heavy chain of an antibody having a first specificity are 30 transfected into a hybridoma cell secreting an antibody having a second specificity. Chemical coupling of antibody fragments has also been used to prepare antigen-binding molecules having specificity for two different antigens (Brennan *et al.*, 1985, *Science* 229: 81-83; Glennie *et al.*, *J. Immunol.*, 1987, 139:2367-2375; and U.S. Patent 6,010,902). Bispecific antibodies can also be produced via recombinant means, for example, by using the leucine zipper moieties from the *Fos* and *Jun* proteins 35 (which preferentially form heterodimers) as described by Kostelny *et al.* (*J. Immunol.* 148:1547-4553; 1992). U.S. Patent 5,582,996 discloses the use of complementary interactive domains (such as leucine zipper moieties or other lock and key interactive domain structures) to facilitate heterodimer formation in the production of bispecific antibodies. Tetravalent, bispecific molecules can be prepared by fusion of DNA encoding the heavy chain of an F(ab')<sub>2</sub> fragment of an antibody with either DNA encoding the heavy chain of a second F(ab')<sub>2</sub> molecule (in which the CH1 domain is replaced by a CH3 domain), or 40 with DNA encoding a single chain FV fragment of an antibody, as described in U.S. Patent 5,959,083. Expression of the resultant fusion genes in mammalian cells, together with the genes for the

5 corresponding light chains, yields tetravalent bispecific molecules having specificity for selected antigens. Bispecific antibodies can also be produced as described in U.S. Patent 5,807,706. Generally, the method involves introducing a protuberance (constructed by replacing small amino acid side chains with larger side chains) at the interface of a first polypeptide and a corresponding cavity (prepared by replacing large amino acid side chains with smaller ones) in the interface of a second polypeptide.

10 Moreover, single-chain variable fragments (sFvs) have been prepared by covalently joining two variable domains; the resulting antibody fragments can form dimers or trimers, depending on the length of a flexible linker between the two variable domains (Kortt *et al.*, 1997, *Protein Engineering* 10:423-433).

Screening procedures by which such antibodies can be identified are well known, and can

15 involve immunoaffinity chromatography, for example. Antibodies can be screened for agonistic (*i.e.*, ligand-mimicking) properties. Such antibodies, upon binding to cell surface HPR1 and/or HPR2, induce biological effects (e.g., transduction of biological signals) similar to the biological effects induced when the HPR1 and/or HPR2 binding partner binds to cell surface HPR1 and/or HPR2. Agonistic antibodies can be used to induce HPR1- and/or HPR2-mediated intracellular signaling or cell

20 proliferation. Bispecific antibodies can be identified by screening with two separate assays, or with an assay wherein the bispecific antibody serves as a bridge between the first antigen and the second antigen (the latter is coupled to a detectable moiety). Bispecific antibodies that bind HPR1 and/or HPR2 polypeptides of the invention via a first antigen binding domain will be useful in diagnostic applications and in treating cell proliferation, differentiation, or activation diseases or conditions.

25 Examples of polypeptides (or other antigens) that the inventive bispecific antibodies bind via a second antigen binding domain include: four alpha helix bundle cytokines such as IL-6, OSM, LIF, CNTF, CLC, IL-12p35, and IL-23p19; soluble hematopoietin receptors such as EBI-3, soluble IL-6R alpha, cytokine-like factor-1 (CLF), IL-12p40, or a soluble form of HPR1 and/or HPR2; and soluble hematopoietin receptors such as EBI-3 etc. in conjunction with a four alpha helix bundle cytokine.

30 Those antibodies that can block binding of the HPR1 and/or HPR2 polypeptides of the invention to binding partners for HPR1 and/or HPR2 can be used to inhibit HPR1- and/or HPR2-mediated intracellular signaling or cell proliferation that results from such binding. Such blocking antibodies can be identified using any suitable assay procedure, such as by testing antibodies for the ability to inhibit binding of HPR1 and/or HPR2 to certain cells expressing an HPR1 and/or HPR2

35 binding partner. Alternatively, blocking antibodies can be identified in assays for the ability to inhibit a biological effect that results from binding of soluble HPR1 and/or HPR2 to target cells. Antibodies can be assayed for the ability to inhibit HPR1 and/or HPR2 binding partner-mediated cell stimulatory pathways, for example. Such an antibody can be employed in an *in vitro* procedure, or administered *in vivo* to inhibit a biological activity mediated by the entity that generated the antibody. Disorders

40 caused or exacerbated (directly or indirectly) by the interaction of HPR1 and/or HPR2 with cell surface binding partner receptor thus can be treated. A therapeutic method involves *in vivo* administration of a blocking antibody to a mammal in an amount effective in inhibiting HPR1 and/or HPR2 binding

5 partner-mediated biological activity. Monoclonal antibodies are generally preferred for use in such therapeutic methods. In one embodiment, an antigen-binding antibody fragment is employed. Compositions comprising an antibody that is directed against HPR1 and/or HPR2, and a physiologically acceptable diluent, excipient, or carrier, are provided herein. Suitable components of such compositions are as described below for compositions containing HPR1 and/or HPR2  
10 polypeptides.

Also provided herein are conjugates comprising a detectable (e.g., diagnostic) or therapeutic agent, attached to the antibody. Examples of such agents are presented above. The conjugates find use in *in vitro* or *in vivo* procedures. The antibodies of the invention can also be used in assays to detect the presence of the polypeptides or fragments of the invention, either *in vitro* or *in vivo*. The antibodies  
15 also can be employed in purifying polypeptides or fragments of the invention by immunoaffinity chromatography.

#### **Rational Design of Compounds that Interact with HPR1 and/or HPR2 Polypeptides**

The goal of rational drug design is to produce structural analogs of biologically active polypeptides of interest or of small molecules with which they interact, e.g., inhibitors, agonists,  
20 antagonists, etc. Any of these examples can be used to fashion drugs which are more active or stable forms of the polypeptide or which enhance or interfere with the function of a polypeptide *in vivo* (Hodgson J (1991) Biotechnology 9:19-21). In one approach, the three-dimensional structure of a polypeptide of interest, or of a polypeptide-inhibitor complex, is determined by x-ray crystallography, by nuclear magnetic resonance, or by computer homology modeling or, most typically, by a  
25 combination of these approaches. Both the shape and charges of the polypeptide must be ascertained to elucidate the structure and to determine active site(s) of the molecule. Less often, useful information regarding the structure of a polypeptide may be gained by modeling based on the structure of homologous polypeptides. In both cases, relevant structural information is used to design analogous HPR1- and/or HPR2-like molecules, to identify efficient inhibitors, or to identify small molecules that  
30 bind HPR1 and/or HPR2 polypeptides. Useful examples of rational drug design include molecules which have improved activity or stability as shown by Braxton S and Wells JA (1992 Biochemistry 31:7796-7801) or which act as inhibitors, agonists, or antagonists of native peptides as shown by Athauda SB et al (1993 J Biochem 113:742-746). The use of HPR1 and/or HPR2 polypeptide structural information in molecular modeling software systems to assist in inhibitor design and in  
35 studying inhibitor-HPR1 polypeptide and/or inhibitor-HPR2 polypeptide interaction is also encompassed by the invention. A particular method of the invention comprises analyzing the three-dimensional structure of HPR1 and/or HPR2 polypeptides for likely binding sites of substrates, synthesizing a new molecule that incorporates a predictive reactive site, and assaying the new molecule as described further herein.

40 It is also possible to isolate a target-specific antibody, selected by functional assay, as described further herein, and then to solve its crystal structure. This approach, in principle, yields a pharmacore upon which subsequent drug design can be based. It is possible to bypass polypeptide

5 crystallography altogether by generating anti-idiotypic antibodies (anti-ids) to a functional, pharmacologically active antibody. As a mirror image of a mirror image, the binding site of the anti-ids would be expected to be an analog of the original receptor. The anti-id could then be used to identify and isolate peptides from banks of chemically or biologically produced peptides. The isolated peptides would then act as the pharmacore.

## 10 Assays of HPR1 and HPR2 Polypeptide Activities

The purified HPR1 and HPR2 polypeptides of the invention (including polypeptides, polypeptides, fragments, variants, oligomers, and other forms) are useful in a variety of assays. For example, the HPR1 and HPR2 molecules of the present invention can be used to identify binding partners of HPR1 and/or HPR2 polypeptides, which can also be used to modulate intracellular  
15 signaling, cell proliferation, or immune cell activity. Alternatively, they can be used to identify non-binding-partner molecules or substances that modulate intracellular signaling, cell proliferation, or immune cell activity.

Assays to Identify Binding Partners. HPR1 and HPR2 polypeptides and fragments thereof can be used to identify binding partners. For example, they can be tested for the ability to bind a candidate  
20 binding partner in any suitable assay, such as a conventional binding assay. To illustrate, the HPR1 or HPR2 polypeptide can be labeled with a detectable reagent (*e.g.*, a radionuclide, chromophore, enzyme that catalyzes a colorimetric or fluorometric reaction, and the like). The labeled polypeptide is contacted with cells expressing the candidate binding partner. The cells then are washed to remove unbound labeled polypeptide, and the presence of cell-bound label is determined by a suitable  
25 technique, chosen according to the nature of the label.

One example of a binding assay procedure is as follows. A recombinant expression vector containing the candidate binding partner cDNA is constructed. CV1-EBNA-1 cells in 10 cm<sup>2</sup> dishes are transfected with this recombinant expression vector. CV-1/EBNA-1 cells (ATCC CRL 10478) constitutively express EBV nuclear antigen-1 driven from the CMV Immediate-early  
30 enhancer/promoter. CV1-EBNA-1 was derived from the African Green Monkey kidney cell line CV-1 (ATCC CCL 70), as described by McMahan *et al.*, (*EMBO J.* 10:2821, 1991). The transfected cells are cultured for 24 hours, and the cells in each dish then are split into a 24-well plate. After culturing an additional 48 hours, the transfected cells (about 4 x 10<sup>4</sup> cells/well) are washed with BM-NFDM, which is binding medium (RPMI 1640 containing 25 mg/ml bovine serum albumin, 2 mg/ml sodium azide, 20  
35 mM Hepes pH 7.2) to which 50 mg/ml nonfat dry milk has been added. The cells then are incubated for 1 hour at 37°C with various concentrations of, for example, a soluble polypeptide/Fc fusion polypeptide made as set forth above. Cells then are washed and incubated with a constant saturating concentration of a <sup>125</sup>I-mouse anti-human IgG in binding medium, with gentle agitation for 1 hour at 37°C. After extensive washing, cells are released *via* trypsinization. The mouse anti-human IgG  
40 employed above is directed against the Fc region of human IgG and can be obtained from Jackson Immunoresearch Laboratories, Inc., West Grove, PA. The antibody is radioiodinated using the standard chloramine-T method. The antibody will bind to the Fc portion of any polypeptide/Fc

5 polypeptide that has bound to the cells. In all assays, non-specific binding of  $^{125}\text{I}$ -antibody is assayed in the absence of the Fc fusion polypeptide/Fc, as well as in the presence of the Fc fusion polypeptide and a 200-fold molar excess of unlabeled mouse anti-human IgG antibody. Cell-bound  $^{125}\text{I}$ -antibody is quantified on a Packard Autogamma counter. Affinity calculations (Scatchard, *Ann. N.Y. Acad. Sci.* 51:660, 1949) are generated on RS/1 (BBN Software, Boston, MA) run on a Microvax computer.

10 Binding can also be detected using methods that are well suited for high-throughput screening procedures, such as scintillation proximity assays (Udenfriend *et al.*, 1985, *Proc Natl Acad Sci USA* 82: 8672-8676), homogeneous time-resolved fluorescence methods (Park *et al.*, 1999, *Anal Biochem* 269: 94-104), fluorescence resonance energy transfer (FRET) methods (Clegg RM, 1995, *Curr Opin Biotechnol* 6: 103-110), or methods that measure any changes in surface plasmon resonance when a

15 bound polypeptide is exposed to a potential binding partner, using for example a biosensor such as that supplied by Biacore AB (Uppsala, Sweden). Compounds that can be assayed for binding to HPR1 and/or HPR2 polypeptides include but are not limited to small organic molecules, such as those that are commercially available - often as part of large combinatorial chemistry compound 'libraries' - from companies such as Sigma-Aldrich (St. Louis, MO), Arqule (Woburn, MA), EnzyMed (Iowa City, IA),

20 Maybridge Chemical Co.(Trevillet, Cornwall, UK), MDS Panlabs (Bothell, WA), Pharmacopeia (Princeton, NJ), and Trega (San Diego, CA). Preferred small organic molecules for screening using these assays are usually less than 10K molecular weight and can possess a number of physicochemical and pharmacological properties which enhance cell penetration, resist degradation, and/or prolong their physiological half-lives (Gibbs, J., 1994, *Pharmaceutical Research in Molecular Oncology, Cell* 79(2):

25 193-198). Compounds including natural products, inorganic chemicals, and biologically active materials such as proteins and toxins can also be assayed using these methods for the ability to bind to HPR1 and/or HPR2 polypeptides.

Yeast Two-Hybrid or "Interaction Trap" Assays. Because HPR1 and HPR2 polypeptides bind or potentially bind to another polypeptide (such as, for example, in a receptor-ligand interaction), the

30 nucleic acid encoding the HPR1 or HPR2 polypeptide can also be used in interaction trap assays (such as, for example, that described in Gyuris *et al.*, *Cell* 75:791-803 (1993)) to identify nucleic acids encoding the other polypeptide with which binding occurs, or to identify inhibitors of the binding interaction. Polypeptides involved in these binding interactions can also be used to screen for peptide or small molecule inhibitors or agonists of the binding interaction.

35 Competitive Binding Assays. Another type of suitable binding assay is a competitive binding assay. To illustrate, biological activity of a variant can be determined by assaying for the variant's ability to compete with the native polypeptide for binding to the candidate binding partner. Competitive binding assays can be performed by conventional methodology. Reagents that can be employed in competitive binding assays include radiolabeled HPR1 or HPR2 and intact cells

40 expressing HPR1 and/or HPR2 (endogenous or recombinant) on the cell surface. For example, a radiolabeled soluble HPR1 or HPR2 fragment can be used to compete with a soluble HPR1 variant and/or a soluble HPR2 variant for binding to cell surface receptors. Instead of intact cells, one could



5 substitute a soluble binding partner/Fc fusion polypeptide bound to a solid phase through the interaction of Polypeptide A or Polypeptide G (on the solid phase) with the Fc moiety. Chromatography columns that contain Polypeptide A and Polypeptide G include those available from Pharmacia Biotech, Inc., Piscataway, NJ.

Assays to Identify Modulators of Intracellular Signaling, Cell Proliferation, or Immune Cell  
10 Activity. The influence of HPR1 or HPR2 on intracellular signaling, cell proliferation, or immune cell activity can be manipulated to control these activities in target cells. For example, the disclosed HPR1 and HPR2 polypeptides, nucleic acids encoding the disclosed HPR1 and HPR2 polypeptides, or agonists or antagonists of such polypeptides can be administered to a cell or group of cells to induce, enhance, suppress, or arrest intracellular signaling or cell proliferation by the target cells. Identification  
15 of HPR1 and HPR2 polypeptides, agonists or antagonists that can be used in this manner can be carried out *via* a variety of assays known to those skilled in the art. Included in such assays are those that evaluate the ability of an HPR1 or HPR2 polypeptide to influence intracellular signaling, cell proliferation, or immune cell activity. Such an assay would involve, for example, the analysis of immune cell interaction in the presence of an HPR1 polypeptide and/or an HPR2 polypeptide. In such  
20 an assay, one would determine a rate of intracellular signaling or cell proliferation in the presence of the HPR1 and/or HPR2 polypeptide and then determine if such intracellular signaling or cell proliferation is altered in the presence of a candidate agonist or antagonist or another HPR1 or HPR2 polypeptide. Exemplary assays for this aspect of the invention include cytokine secretion assays, cell proliferation assays, and mixed lymphocyte reactions involving antigen presenting cells and T cells.  
25 These assays are well known to those skilled in the art.

In another aspect, the present invention provides a method of detecting the ability of a test compound to affect the intracellular signaling or cell proliferation activity of a cell. In this aspect, the method comprises: (1) contacting a first group of target cells with a test compound including an HPR1 polypeptide and/or an HPR2 polypeptide, or a fragment or fragments thereof, under conditions  
30 appropriate to the particular assay being used; (2) measuring the net rate of intracellular signaling or cell proliferation among the target cells; and (3) observing the net rate of intracellular signaling or cell proliferation among control cells contacting the HPR1 and/or HPR2 polypeptides or fragments thereof, in the absence of a test compound, under otherwise identical conditions as the first group of cells. In this embodiment, the net rate of intracellular signaling or cell proliferation in the control cells is  
35 compared to that of the cells treated with both a test compound and the HPR1 and/or HPR2 polypeptide(s). The comparison will provide a difference in the net rate of intracellular signaling or cell proliferation such that an effector of intracellular signaling or cell proliferation can be identified. The test compound can function as an effector by either activating or up-regulating, or by inhibiting or down-regulating, intracellular signaling or cell proliferation, and can be detected through this method.

40 Cell Proliferation, Cell Death, Cell Differentiation, and Cell Adhesion Assays. A polypeptide of the present invention may exhibit cytokine, cell proliferation (either inducing or inhibiting), or cell differentiation (either inducing or inhibiting) activity, or may induce production of other cytokines in

5 certain cell populations. Many polypeptide factors discovered to date have exhibited such activity in one or more factor-dependent cell proliferation assays, and hence the assays serve as a convenient confirmation of cell stimulatory activity. The activity of a polypeptide of the present invention is evidenced by any one of a number of routine factor-dependent cell proliferation assays for cell lines including, without limitation, 32D, DA2, DA1G, T10, B9, B9/11, BaF3, MC9/G, M+ (preB M+), 2E8,  
 10 RB5, DA1, 123, T1165, HT2, CTLL2, TF-1, Mo7e and CMK. The activity of an HPR1 or HPR2 polypeptide of the invention may, among other means, be measured by the following methods:

Assays for T-cell or thymocyte proliferation include without limitation those described in: *Current Protocols in Immunology*, Coligan *et al.* eds, Greene Publishing Associates and Wiley-Interscience (pp. 3.1-3.19: *In vitro* assays for mouse lymphocyte function; Chapter 7: Immunologic  
 15 studies in humans); Takai *et al.*, J. Immunol. 137: 3494-3500, 1986; Bertagnolli *et al.*, J. Immunol. 145: 1706-1712, 1990; Bertagnolli *et al.*, Cellular Immunology 133:327-341, 1991; Bertagnolli, *et al.*, J. Immunol. 149:3778-3783, 1992; Bowman *et al.*, J. Immunol. 152: 1756-1761, 1994.

Assays for cytokine production and/or proliferation of spleen cells, lymph node cells or thymocytes include, without limitation, those described in: Kruisbeek and Shevach, 1994, Polyclonal  
 20 T cell stimulation, in *Current Protocols in Immunology*, Coligan *et al.* eds. Vol 1 pp. 3.12.1-3.12.14, John Wiley and Sons, Toronto; and Schreiber, 1994, Measurement of mouse and human interferon gamma in *Current Protocols in Immunology*, Coligan *et al.* eds. Vol 1 pp. 6.8.1-6.8.8, John Wiley and Sons, Toronto.

Assays for proliferation and differentiation of hematopoietic and lymphopoietic cells include, without limitation, those described in: Bottomly *et al.*, 1991, Measurement of human and murine  
 25 interleukin 2 and interleukin 4, in *Current Protocols in Immunology*, Coligan *et al.* eds. Vol 1 pp. 6.3.1-6.3.12, John Wiley and Sons, Toronto; deVries *et al.*, J Exp Med 173: 1205-1211, 1991; Moreau *et al.*, Nature 336:690-692, 1988; Greenberger *et al.*, Proc Natl Acad Sci.USA 80: 2931-2938, 1983; Nordan, 1991, Measurement of mouse and human interleukin 6, in *Current Protocols in Immunology*  
 30 Coligan *et al.* eds. Vol 1 pp. 6.6.1-6.6.5, John Wiley and Sons, Toronto; Smith *et al.*, Proc Natl Acad Sci USA 83: 1857-1861, 1986; Bennett *et al.*, 1991, Measurement of human interleukin 11, in *Current Protocols in Immunology* Coligan *et al.* eds. Vol 1 pp. 6.15.1 John Wiley and Sons, Toronto; Ciarletta *et al.*, 1991, Measurement of mouse and human Interleukin 9, in *Current Protocols in Immunology* Coligan *et al.* eds. Vol 1 pp. 6.13.1, John Wiley and Sons, Toronto.

35 Assays for T-cell clone responses to antigens (which will identify, among others, polypeptides that affect APC-T cell interactions as well as direct T-cell effects by measuring proliferation and cytokine production) include, without limitation, those described in: *Current Protocols in Immunology*, Coligan *et al.* eds, Greene Publishing Associates and Wiley-Interscience (Chapter 3: *In vitro* assays for mouse lymphocyte function; Chapter 6: Cytokines and their cellular receptors; Chapter 7: Immunologic  
 40 studies in humans); Weinberger *et al.*, Proc Natl Acad Sci USA 77: 6091-6095, 1980; Weinberger *et al.*, Eur. J. Immun. 11:405-411, 1981; Takai *et al.*, J. Immunol. 137:3494-3500, 1986; Takai *et al.*, J. Immunol. 140:508-512, 1988

- 5        Assays for thymocyte or splenocyte cytotoxicity include, without limitation, those described in: *Current Protocols in Immunology*, Coligan *et al.* eds, Greene Publishing Associates and Wiley-Interscience (Chapter 3, In Vitro assays for Mouse Lymphocyte Function 3.1-3.19; Chapter 7, Immunologic studies in Humans); Herrmann *et al.*, *Proc. Natl. Acad. Sci. USA* 78:2488-2492, 1981; Herrmann *et al.*, *J. Immunol.* 128:1968-1974, 1982; Handa *et al.*, *J. Immunol.* 135:1564-1572, 1985;
- 10      Takai *et al.*, *J. Immunol.* 137:3494-3500, 1986; Takai *et al.*, *J. Immunol.* 140:508-512, 1988; Herrmann *et al.*, *Proc. Natl. Acad. Sci. USA* 78:2488-2492, 1981; Herrmann *et al.*, *J. Immunol.* 128:1968-1974, 1982; Handa *et al.*, *J. Immunol.* 135:1564-1572, 1985; Takai *et al.*, *J. Immunol.* 137:3494-3500, 1986; Bowman *et al.*, *J. Virology* 61:1992-1998; Takai *et al.*, *J. Immunol.* 140:508-512, 1988; Bertagnolli *et al.*, *Cellular Immunology* 133:327-341, 1991; Brown *et al.*, *J. Immunol.* 153:3079-3092, 1994.
- 15        Assays for T-cell-dependent immunoglobulin responses and isotype switching (which will identify, among others, polypeptides that modulate T-cell dependent antibody responses and that affect Th1/Th2 profiles) include, without limitation, those described in: Maliszewski, *J Immunol* 144: 3028-3033, 1990; and Mond and Brunswick, 1994, Assays for B cell function: *in vitro* antibody production, in *Current Protocols in Immunology* Coligan *et al.* eds. Vol 1 pp. 3.8.1-3.8.16, John Wiley and Sons,
- 20      Toronto.
- Mixed lymphocyte reaction (MLR) assays (which will identify, among others, polypeptides that generate predominantly Th1 and CTL responses) include, without limitation, those described in: *Current Protocols in Immunology*, Coligan *et al.* eds, Greene Publishing Associates and Wiley-Interscience (Chapter 3, In Vitro assays for Mouse Lymphocyte Function 3.1-3.19; Chapter 7,
- 25      Immunologic studies in Humans); Takai *et al.*, *J. Immunol.* 137:3494-3500, 1986; Takai *et al.*, *J. Immunol.* 140:508-512, 1988; Bertagnolli *et al.*, *J. Immunol.* 149:3778-3783, 1992.
- Dendritic cell-dependent assays (which will identify, among others, polypeptides expressed by dendritic cells that activate naive T-cells) include, without limitation, those described in: Guery *et al.*, *J. Immunol* 134:536-544, 1995; Inaba *et al.*, *J Exp Med* 173:549-559, 1991; Macatonia *et al.*, *J Immunol*
- 30      154:5071-5079, 1995; Porgador *et al.*, *J Exp Med* 182:255-260, 1995; Nair *et al.*, *J Virology* 67:4062-4069, 1993; Huang *et al.*, *Science* 264:961-965, 1994; Macatonia *et al.*, *J Exp Med* 169:1255-1264, 1989; Bhardwaj *et al.*, *J Clin Invest* 94:797-807, 1994; and Inaba *et al.*, *J Exp Med* 172:631-640, 1990.
- Assays for lymphocyte survival/apoptosis (which will identify, among others, polypeptides that prevent apoptosis after superantigen induction and polypeptides that regulate lymphocyte
- 35      homeostasis) include, without limitation, those described in: Darzynkiewicz *et al.*, *Cytometry* 13:795-808, 1992; Gorczyca *et al.*, *Leukemia* 7:659-670, 1993; Gorczyca *et al.*, *Cancer Research* 53:1945-1951, 1993; Itoh *et al.*, *Cell* 66:233-243, 1991; Zacharchuk, *J Immunol* 145:4037-4045, 1990; Zamai *et al.*, *Cytometry* 14:891-897, 1993; Gorczyca *et al.*, *International Journal of Oncology* 1:639-648, 1992.
- Assays for polypeptides that influence early steps of T-cell commitment and development
- 40      include, without limitation, those described in: Antica *et al.*, *Blood* 84:111-117, 1994; Fine *et al.*, *Cell Immunol* 155:111-122, 1994; Galy *et al.*, *Blood* 85:2770-2778, 1995; Toki *et al.*, *Proc Natl Acad Sci. USA* 88:7548-7551, 1991

5           Assays for embryonic stem cell differentiation (which will identify, among others, polypeptides that influence embryonic differentiation hematopoiesis) include, without limitation, those described in: Johansson et al. Cellular Biology 15:141-151, 1995; Keller et al., Molecular and Cellular Biology 13:473-486, 1993; McClanahan et al., Blood 81:2903-2915, 1993.

10           Assays for stem cell survival and differentiation (which will identify, among others, polypeptides that regulate lympho-hematopoiesis) include, without limitation, those described in: Methylcellulose colony forming assays, Freshney, 1994, In *Culture of Hematopoietic Cells*, Freshney et al. eds. pp. 265-268, Wiley-Liss, Inc., New York, NY; Hirayama et al., Proc. Natl. Acad. Sci. USA 89:5907-5911, 1992; Primitive hematopoietic colony forming cells with high proliferative potential, McNiece and Briddell, 1994, In *Culture of Hematopoietic Cells*, Freshney et al. eds. pp. 23-39, Wiley-  
15 Liss, Inc., New York, NY; Neben et al., Experimental Hematology 22:353-359, 1994; Ploemacher, 1994, Cobblestone area forming cell assay, In *Culture of Hematopoietic Cells*, Freshney et al. eds. pp. 1-21, Wiley-Liss, Inc., New York, NY; Spooncer et al., 1994, Long term bone marrow cultures in the presence of stromal cells, In *Culture of Hematopoietic Cells*, Freshney et al. eds. pp. 163-179, Wiley-  
20 Liss, Inc., New York, NY; Sutherland, 1994, Long term culture initiating cell assay, In *Culture of Hematopoietic Cells*, Freshney et al. eds. Vol pp. 139-162, Wiley-Liss, Inc., New York, NY.

Assay for hemostatic and thrombolytic activity include, without limitation, those described in: Linet et al., J. Clin. Pharmacol. 26:131-140, 1986; Burdick et al., Thrombosis Res. 45:413-419, 1987; Humphrey et al., Fibrinolysis 5:71-79 (1991); Schaub, Prostaglandins 35:467-474, 1988.

25           Assays for receptor-ligand activity include without limitation those described in: *Current Protocols in Immunology* Coligan et al. eds, Greene Publishing Associates and Wiley-Interscience (Chapter 7.28, Measurement of cellular adhesion under static conditions 7.28.1-7.28.22), Takai et al., Proc. Natl. Acad. Sci. USA 84:6864-6868, 1987; Bierer et al., J. Exp. Med. 168:1145-1156, 1988; Rosenstein et al., J. Exp. Med. 169:149-160 1989; Stoltenborg et al., J. Immunol. Methods 175:59-68, 1994; Stitt et al., Cell 80:661-670, 1995.

### 30   **Diagnostic and Other Uses of HPR1 and HPR2 Polypeptides and Nucleic Acids**

          The nucleic acids encoding the HPR1 and HPR2 polypeptides provided by the present invention can be used for numerous diagnostic or other useful purposes. The nucleic acids of the invention can be used to express recombinant polypeptide for analysis, characterization or therapeutic use; as markers for tissues in which the corresponding polypeptide is preferentially expressed (either  
35   constitutively or at a particular stage of tissue differentiation or development or in disease states); as molecular weight markers on Southern gels; as chromosome markers or tags (when labeled) to identify chromosomes or to map related gene positions; to compare with endogenous DNA sequences in patients to identify potential genetic disorders; as probes to hybridize and thus discover novel, related DNA sequences; as a source of information to derive PCR primers for genetic fingerprinting; as a  
40   probe to "subtract-out" known sequences in the process of discovering other novel nucleic acids; for selecting and making oligomers for attachment to a "gene chip" or other support, including for examination of expression patterns; to raise anti-polypeptide antibodies using DNA immunization

5 techniques; as an antigen to raise anti-DNA antibodies or elicit another immune response, and. for gene therapy. Uses of HPR1 and HPR2 polypeptides and fragmented polypeptides include, but are not limited to, the following: purifying polypeptides and measuring the activity thereof; delivery agents; therapeutic and research reagents; molecular weight and isoelectric focusing markers; controls for peptide fragmentation; identification of unknown polypeptides; and preparation of antibodies. Any or  
10 all nucleic acids suitable for these uses are capable of being developed into reagent grade or kit format for commercialization as products. Methods for performing the uses listed above are well known to those skilled in the art. References disclosing such methods include without limitation "Molecular Cloning: A Laboratory Manual", 2d ed., Cold Spring Harbor Laboratory Press, Sambrook, J., E. F. Fritsch and T. Maniatis eds., 1989, and "Methods in Enzymology: Guide to Molecular Cloning  
15 Techniques", Academic Press, Berger, S. L. and A. R. Kimmel eds., 1987

Probes and Primers. Among the uses of the disclosed HPR1 and HPR2 nucleic acids, and combinations of fragments thereof, is the use of fragments as probes or primers. Such fragments generally comprise at least about 17 contiguous nucleotides of a DNA sequence. In other  
20 embodiments, a DNA fragment comprises at least 30, or at least 60, contiguous nucleotides of a DNA sequence. The basic parameters affecting the choice of hybridization conditions and guidance for devising suitable conditions are set forth by Sambrook et al., 1989 and are described in detail above. Using knowledge of the genetic code in combination with the amino acid sequences set forth above, sets of degenerate oligonucleotides can be prepared. Such oligonucleotides are useful as primers, e.g., in polymerase chain reactions (PCR), whereby DNA fragments are isolated and amplified. In certain  
25 embodiments, degenerate primers can be used as probes for non-human genetic libraries. Such libraries would include but are not limited to cDNA libraries, genomic libraries, and even electronic EST (express sequence tag) or DNA libraries. Homologous sequences identified by this method would then be used as probes to identify non-human HPR1 and HPR2 homologues.

Chromosome Mapping. The nucleic acids encoding HPR1 and HPR2 polypeptides, and the  
30 disclosed fragments and combinations of these nucleic acids, can be used by those skilled in the art using well-known techniques to identify the human chromosome to which these nucleic acids map. Useful techniques include, but are not limited to, using the sequence or portions, including oligonucleotides, as a probe in various well-known techniques such as radiation hybrid mapping (high resolution), in situ hybridization to chromosome spreads (moderate resolution), and Southern blot  
35 hybridization to hybrid cell lines containing individual human chromosomes (low resolution). Alternatively, the genomic sequences corresponding to nucleic acids encoding a cytokine polypeptide of the invention are mapped by comparison to sequences in public and proprietary databases, such as GenBank (ncbi.nlm.nih.gov/BLAST), Locuslink (ncbi.nlm.nih.gov:80/LocusLink/), Unigene (ncbi.nlm.nih.gov/cgi-bin/UniGene), AceView (ncbi.nlm.nih.gov/AceView), Gene Map Viewer  
40 (ncbi.nlm.nih.gov/genemap), Online Mendelian Inheritance in Man (OMIM) (ncbi.nlm.nih.gov/Omim), and proprietary databases such as the Celera Discovery System (celera.com). These computer analyses of available genomic sequence information can provide the identification of the specific chromosomal

5 location of human and/or murine genomic sequences corresponding to sequences encoding HPR1 or HPR2 polypeptides of the invention, and the unique genetic mapping relationships between HPR1 or HPR2 genomic sequences and the genetic map locations of known human genetic disorders

Diagnostics and Gene Therapy. The nucleic acids encoding HPR1 and HPR2 polypeptides, and the disclosed fragments and combinations of these nucleic acids can be used by one skilled in the art using well-known techniques to analyze abnormalities associated with the genes corresponding to these polypeptides. This enables one to distinguish conditions in which this marker is rearranged or deleted. In addition, nucleic acids of the invention or a fragment thereof can be used as a positional marker to map other genes of unknown location. The DNA can be used in developing treatments for any disorder mediated (directly or indirectly) by defective, or insufficient amounts of, the genes corresponding to the nucleic acids of the invention. Disclosure herein of native nucleotide sequences permits the detection of defective genes, and the replacement thereof with normal genes. Defective genes can be detected in *in vitro* diagnostic assays, and by comparison of a native nucleotide sequence disclosed herein with that of a gene derived from a person suspected of harboring a defect in this gene.

Methods of Screening for Binding Partners. The HPR1 and HPR2 polypeptides of the invention each can be used as reagents in methods to screen for or identify binding partners. For example, the HPR1 and HPR2 polypeptides can be attached to a solid support material and may bind to their binding partners in a manner similar to affinity chromatography. In particular embodiments, a polypeptide is attached to a solid support by conventional procedures. As one example, chromatography columns containing functional groups that will react with functional groups on amino acid side chains of polypeptides are available (Pharmacia Biotech, Inc., Piscataway, NJ). In an alternative, a polypeptide/Fc polypeptide (as discussed above) is attached to Protein A- or Protein G-containing chromatography columns through interaction with the Fc moiety. The HPR1 and HPR2 polypeptides also find use in identifying cells that express a binding partner on the cell surface. Polypeptides are bound to a solid phase such as a column chromatography matrix or a similar suitable substrate. For example, magnetic microspheres can be coated with the polypeptides and held in an incubation vessel through a magnetic field. Suspensions of cell mixtures containing potential binding-partner-expressing cells are contacted with the solid phase having the polypeptides thereon. Cells expressing the binding partner on the cell surface bind to the fixed polypeptides, and unbound cells are washed away. Alternatively, HPR1 and HPR2 polypeptides can be conjugated to a detectable moiety, then incubated with cells to be tested for binding partner expression. After incubation, unbound labeled matter is removed and the presence or absence of the detectable moiety on the cells is determined. In a further alternative, mixtures of cells suspected of expressing the binding partner are incubated with biotinylated polypeptides. Incubation periods are typically at least one hour in duration to ensure sufficient binding. The resulting mixture then is passed through a column packed with avidin-coated beads, whereby the high affinity of biotin for avidin provides binding of the desired cells to the beads. Procedures for using avidin-coated beads are known (see Berenson, et al. *J. Cell. Biochem.*, 10D:239, 1986). Washing to remove unbound material, and the release of the bound cells,

5 are performed using conventional methods. In some instances, the above methods for screening for or identifying binding partners may also be used or modified to isolate or purify such binding partner molecules or cells expressing them.

Measuring Biological Activity. HPR1 and HPR2 polypeptides also find use in measuring the biological activity of HPR1-binding and/or HPR2-binding polypeptides in terms of their binding  
10 affinity. The polypeptides thus can be employed by those conducting "quality assurance" studies, e.g., to monitor shelf life and stability of polypeptide under different conditions. For example, the polypeptides can be employed in a binding affinity study to measure the biological activity of a binding partner polypeptide that has been stored at different temperatures, or produced in different cell types. The polypeptides also can be used to determine whether biological activity is retained after  
15 modification of a binding partner polypeptide (e.g., chemical modification, truncation, mutation, etc.). The binding affinity of the modified polypeptide is compared to that of an unmodified binding polypeptide to detect any adverse impact of the modifications on biological activity of the binding polypeptide. The biological activity of a binding polypeptide thus can be ascertained before it is used in a research study, for example.

20 Carriers and Delivery Agents. The polypeptides also find use as carriers for delivering agents attached thereto to cells bearing identified binding partners. The polypeptides thus can be used to deliver diagnostic or therapeutic agents to such cells (or to other cell types found to express binding partners on the cell surface) in *in vitro* or *in vivo* procedures. Detectable (diagnostic) and therapeutic  
25 agents that can be attached to a polypeptide include, but are not limited to, toxins, other cytotoxic agents, drugs, radionuclides, chromophores, enzymes that catalyze a colorimetric or fluorometric reaction, and the like, with the particular agent being chosen according to the intended application. Among the toxins are ricin, abrin, diphtheria toxin, *Pseudomonas aeruginosa* exotoxin A, ribosomal inactivating polypeptides, mycotoxins such as trichothecenes, and derivatives and fragments (e.g., single chains) thereof. Radionuclides suitable for diagnostic use include, but are not limited to,  $^{123}\text{I}$ ,  
30  $^{131}\text{I}$ ,  $^{99\text{m}}\text{Tc}$ ,  $^{111}\text{In}$ , and  $^{76}\text{Br}$ . Examples of radionuclides suitable for therapeutic use are  $^{131}\text{I}$ ,  $^{211}\text{At}$ ,  $^{77}\text{Br}$ ,  $^{186}\text{Re}$ ,  $^{188}\text{Re}$ ,  $^{212}\text{Pb}$ ,  $^{212}\text{Bi}$ ,  $^{109}\text{Pd}$ ,  $^{64}\text{Cu}$ , and  $^{67}\text{Cu}$ . Such agents can be attached to the polypeptide by any suitable conventional procedure. The polypeptide comprises functional groups on amino acid side chains that can be reacted with functional groups on a desired agent to form covalent bonds, for example. Alternatively, the polypeptide or agent can be derivatized to generate or attach a desired  
35 reactive functional group. The derivatization can involve attachment of one of the bifunctional coupling reagents available for attaching various molecules to polypeptides (Pierce Chemical Company, Rockford, Illinois). A number of techniques for radiolabeling polypeptides are known. Radionuclide metals can be attached to polypeptides by using a suitable bifunctional chelating agent, for example. Conjugates comprising polypeptides and a suitable diagnostic or therapeutic agent  
40 (preferably covalently linked) are thus prepared. The conjugates are administered or otherwise employed in an amount appropriate for the particular application.

## 5     **Treating Diseases Using HPR1 and/or HPR2 Polypeptides and Antagonists Thereof**

It is anticipated that the HPR1 and HPR2 polypeptides, fragments, variants, antagonists, agonists, antibodies, and binding partners of the invention will be useful for treating medical conditions and diseases including, but not limited to, cell proliferation, metabolic, and reproductive hormone related conditions as described further herein. The therapeutic molecule or molecules to be used will  
10     depend on the etiology of the condition to be treated and the biological pathways involved, and variants, fragments, and binding partners of HPR1 and/or HPR2 polypeptides may have effects similar to or different from HPR1 or HPR2 polypeptides. For example, an antagonist of the ligand-binding activity of HPR1 and/or HPR2 polypeptides may be selected for treatment of conditions involving ligand-binding activity, but a particular fragment of a given HPR1 or HPR2 polypeptide may also act  
15     as an effective dominant negative antagonist of that activity. Therefore, in the following paragraphs “HPR1 and HPR2 polypeptides or antagonists” refers to all HPR1 and HPR2 polypeptides, fragments, variants, antagonists, agonists, antibodies, and binding partners etc. of the invention, and it is understood that a specific molecule or molecules can be selected from those provided as embodiments of the invention by individuals of skill in the art, according to the biological and therapeutic  
20     considerations described herein.

Provided herein are methods for using HPR1 and HPR2 polypeptides or antagonists, compositions or combination therapies to treat various hematologic and oncologic disorders. For example, HPR1 and HPR2 polypeptides or antagonists are used to treat various forms of cancer, including acute myelogenous leukemia, Epstein-Barr virus-positive nasopharyngeal carcinoma, glioma,  
25     colon, stomach, prostate, renal cell, cervical and ovarian cancers, lung cancer (SCLC and NSCLC), including cancer-associated cachexia, fatigue, asthenia, paraneoplastic syndrome of cachexia and hypercalcemia. Additional diseases treatable with the subject HPR1 and HPR2 polypeptides or antagonists, compositions or combination therapies are solid tumors, including sarcoma, osteosarcoma, and carcinoma, such as adenocarcinoma (for example, breast cancer) and squamous cell carcinoma. In  
30     addition, the subject compounds, compositions or combination therapies are useful for treating leukemia, including acute myelogenous leukemia, chronic or acute lymphoblastic leukemia and hairy cell leukemia. Other malignancies with invasive metastatic potential can be treated with the subject compounds, compositions and combination therapies, including multiple myeloma. In addition, the disclosed HPR1 and HPR2 polypeptides or antagonists, compositions and combination therapies can be  
35     used to treat anemias and hematologic disorders, including anemia of chronic disease, aplastic anemia, including Fanconi’s aplastic anemia; idiopathic thrombocytopenic purpura (ITP); myelodysplastic syndromes (including refractory anemia, refractory anemia with ringed sideroblasts, refractory anemia with excess blasts, refractory anemia with excess blasts in transformation); myelofibrosis/myeloid metaplasia; and sickle cell vasocclusive crisis.

40     Various lymphoproliferative disorders also are treatable with the disclosed HPR1 and HPR2 polypeptides or antagonists, compositions or combination therapies. These include, but are not limited to autoimmune lymphoproliferative syndrome (ALPS), chronic lymphoblastic leukemia, hairy cell



5 leukemia, chronic lymphatic leukemia, peripheral T-cell lymphoma, small lymphocytic lymphoma, mantle cell lymphoma, follicular lymphoma, Burkitt's lymphoma, Epstein-Barr virus-positive T cell lymphoma, histiocytic lymphoma, Hodgkin's disease, diffuse aggressive lymphoma, acute lymphatic leukemias, T gamma lymphoproliferative disease, cutaneous B cell lymphoma, cutaneous T cell lymphoma (i.e., mycosis fungoides) and Sézary syndrome.

10 In addition, the subject invention provides HPR1 and HPR2 polypeptides or antagonists, compositions and combination therapies for the treatment of non-arthritic medical conditions of the bones and joints. This encompasses osteoclast disorders that lead to bone loss, such as but not limited to osteoporosis, including post-menopausal osteoporosis, periodontitis resulting in tooth loosening or loss, and prosthesis loosening after joint replacement (generally associated with an inflammatory response to wear debris). This latter condition also is called "orthopedic implant osteolysis." Another condition treatable by administering HPR1 and HPR2 polypeptides or antagonists, is temporal  
15 mandibular joint dysfunction (TMJ).

The disclosed HPR1 and HPR2 polypeptides or antagonists, compositions and combination therapies furthermore are useful for treating neurodegenerative conditions such as acute  
20 polyneuropathy; anorexia nervosa; Bell's palsy; chronic fatigue syndrome; transmissible dementia, including Creutzfeld-Jacob disease; demyelinating neuropathy; Guillain-Barre syndrome; vertebral disc disease; Gulf war syndrome; myasthenia gravis; chronic neuronal degeneration; and stroke, including cerebral ischemic diseases.

#### 25 **Administration of HPR1 and HPR2 Polypeptides and Antagonists Thereof**

This invention provides compounds, compositions, and methods for treating a patient, preferably a mammalian patient, and most preferably a human patient, who is suffering from a medical disorder, and in particular an HPR1- or HPR2-mediated disorder. Such HPR1- or HPR2-mediated disorders include conditions caused (directly or indirectly) or exacerbated by binding between HPR1  
30 and/or HPR2 and a binding partner. For purposes of this disclosure, the terms "illness," "disease," "medical condition," "abnormal condition" and the like are used interchangeably with the term "medical disorder." The terms "treat", "treating", and "treatment" used herein includes curative, preventative (e.g., prophylactic) and palliative or ameliorative treatment. For such therapeutic uses, HPR1 and HPR2 polypeptides and fragments, HPR1 and HPR2 nucleic acids encoding the HPR1 and  
35 HPR2 polypeptides, and/or agonists or antagonists of the HPR1 and/or HPR2 polypeptides such as antibodies can be administered to the patient in need through well-known means. Compositions of the present invention can contain a polypeptide in any form described herein, such as native polypeptides, variants, derivatives, oligomers, and biologically active fragments. In particular embodiments, the composition comprises a soluble polypeptide or an oligomer comprising soluble HPR1 and/or HPR2  
40 polypeptides.

Therapeutically Effective Amount. In practicing the method of treatment or use of the present invention, a therapeutically effective amount of a therapeutic agent of the present invention is

5 administered to a patient having a condition to be treated, preferably to treat or ameliorate diseases associated with the activity of an HPR1 and/or HPR2 polypeptide. "Therapeutic agent" includes without limitation any of the HPR1 or HPR2 polypeptides, fragments, and variants; nucleic acids encoding the HPR1 and HPR2 polypeptides, fragments, and variants; agonists or antagonists of the HPR1 and HPR2 polypeptides such as antibodies; HPR1 and/or HPR2 polypeptide binding partners;  
10 complexes formed from the HPR1 and/or HPR2 polypeptides, fragments, variants, and binding partners, etc. As used herein, the term "therapeutically effective amount" means the total amount of each therapeutic agent or other active component of the pharmaceutical composition or method that is sufficient to show a meaningful patient benefit, i.e., treatment, healing, prevention or amelioration of the relevant medical condition, or an increase in rate of treatment, healing, prevention or amelioration  
15 of such conditions. When applied to an individual therapeutic agent or active ingredient, administered alone, the term refers to that ingredient alone. When applied to a combination, the term refers to combined amounts of the ingredients that result in the therapeutic effect, whether administered in combination, serially or simultaneously. As used herein, the phrase "administering a therapeutically effective amount" of a therapeutic agent means that the patient is treated with said therapeutic agent in  
20 an amount and for a time sufficient to induce an improvement, and preferably a sustained improvement, in at least one indicator that reflects the severity of the disorder. An improvement is considered "sustained" if the patient exhibits the improvement on at least two occasions separated by one or more weeks. The degree of improvement is determined based on signs or symptoms, and determinations can also employ questionnaires that are administered to the patient, such as quality-of-  
25 life questionnaires. Various indicators that reflect the extent of the patient's illness can be assessed for determining whether the amount and time of the treatment is sufficient. The baseline value for the chosen indicator or indicators is established by examination of the patient prior to administration of the first dose of the therapeutic agent. Preferably, the baseline examination is done within about 60 days of administering the first dose. If the therapeutic agent is being administered to treat acute symptoms, the first dose is administered as soon as practically possible after the injury has occurred. Improvement is induced by administering therapeutic agents such as HPR1 and/or HPR2 polypeptides or antagonists until the patient manifests an improvement over baseline for the chosen indicator or indicators. In treating chronic conditions, this degree of improvement is obtained by repeatedly administering this medicament over a period of at least a month or more, e.g., for one, two, or three months or longer, or  
35 indefinitely. A period of one to six weeks, or even a single dose, often is sufficient for treating injuries or acute conditions. Although the extent of the patient's illness after treatment may appear improved according to one or more indicators, treatment may be continued indefinitely at the same level or at a reduced dose or frequency. Once treatment has been reduced or discontinued, it later may be resumed at the original level if symptoms should reappear.

40 Dosing. One skilled in the pertinent art will recognize that suitable dosages will vary, depending upon such factors as the nature and severity of the disorder to be treated, the patient's body weight, age, general condition, and prior illnesses and/or treatments, and the route of administration.

5 Preliminary doses can be determined according to animal tests, and the scaling of dosages for human administration is performed according to art-accepted practices such as standard dosing trials. For example, the therapeutically effective dose can be estimated initially from cell culture assays. The dosage will depend on the specific activity of the compound and can be readily determined by routine experimentation. A dose can be formulated in animal models to achieve a circulating plasma  
10 concentration range that includes the IC<sub>50</sub> (*i.e.*, the concentration of the test compound which achieves a half-maximal inhibition of symptoms) as determined in cell culture, while minimizing toxicities. Such information can be used to more accurately determine useful doses in humans. Ultimately, the attending physician will decide the amount of polypeptide of the present invention with which to treat each individual patient. Initially, the attending physician will administer low doses of polypeptide of  
15 the present invention and observe the patient's response. Larger doses of polypeptide of the present invention can be administered until the optimal therapeutic effect is obtained for the patient, and at that point the dosage is not increased further. It is contemplated that the various pharmaceutical compositions used to practice the method of the present invention should contain about 0.01 ng to about 100 mg (preferably about 0.1 ng to about 10 mg, more preferably about 0.1 microgram to about 1  
20 mg) of polypeptide of the present invention per kg body weight. In one embodiment of the invention, HPR1 and/or HPR2 polypeptides or antagonists are administered one time per week to treat the various medical disorders disclosed herein, in another embodiment is administered at least two times per week, and in another embodiment is administered at least three times per week. If injected, the effective amount of HPR1 or HPR2 polypeptides or antagonists per adult dose ranges from 1-20 mg/m<sup>2</sup>, and preferably is about 5-12 mg/m<sup>2</sup>. Alternatively, a flat dose can be administered, whose amount may  
25 range from 5-100 mg/dose. Exemplary dose ranges for a flat dose to be administered by subcutaneous injection are 5-25 mg/dose, 25-50 mg/dose and 50-100 mg/dose. In one embodiment of the invention, the various indications described below are treated by administering a preparation acceptable for injection containing HPR1 and/or HPR2 polypeptides or antagonists at 25 mg/dose, or alternatively, containing 50 mg per dose. The 25 mg or 50 mg dose can be administered repeatedly, particularly for  
30 chronic conditions. If a route of administration other than injection is used, the dose is appropriately adjusted in accord with standard medical practices. In many instances, an improvement in a patient's condition will be obtained by injecting a dose of about 25 mg of HPR1 or HPR2 polypeptides or antagonists one to three times per week over a period of at least three weeks, or a dose of 50 mg of  
35 HPR1 or HPR2 polypeptides or antagonists one or two times per week for at least three weeks, though treatment for longer periods may be necessary to induce the desired degree of improvement. For incurable chronic conditions, the regimen can be continued indefinitely, with adjustments being made to dose and frequency if such are deemed necessary by the patient's physician. The foregoing doses are examples for an adult patient who is a person who is 18 years of age or older. For pediatric patients  
40 (age 4-17), a suitable regimen involves the subcutaneous injection of 0.4 mg/kg, up to a maximum dose of 25 mg of HPR1 or HPR2 polypeptides or antagonists, administered by subcutaneous injection one or more times per week. If an antibody against an HPR1 and/or HPR2 polypeptide is used as the HPR1

5 and/or HPR2 polypeptide antagonist, a preferred dose range is 0.1 to 20 mg/kg, and more preferably is 1-10 mg/kg. Another preferred dose range for an anti-HPR1 polypeptide and/or anti-HPR2 polypeptide antibody is 0.75 to 7.5 mg/kg of body weight. Humanized antibodies are preferred, that is, antibodies in which only the antigen-binding portion of the antibody molecule is derived from a non-human source. Such antibodies can be injected or administered intravenously.

10 Formulations. Compositions comprising an effective amount of an HPR1 and/or HPR2 polypeptide of the present invention (from whatever source derived, including without limitation from recombinant and non-recombinant sources), in combination with other components such as a physiologically acceptable diluent, carrier, or excipient, are provided herein. The term  
15 "pharmaceutically acceptable" means a non-toxic material that does not interfere with the effectiveness of the biological activity of the active ingredient(s). Formulations suitable for administration include aqueous and non-aqueous sterile injection solutions which can contain anti-oxidants, buffers, bacteriostats and solutes which render the formulation isotonic with the blood of the recipient; and aqueous and non-aqueous sterile suspensions which can include suspending agents or thickening agents. The polypeptides can be formulated according to known methods used to prepare  
20 pharmaceutically useful compositions. They can be combined in admixture, either as the sole active material or with other known active materials suitable for a given indication, with pharmaceutically acceptable diluents, preservatives, emulsifiers, solubilizers, adjuvants and/or carriers. Suitable formulations for pharmaceutical compositions include those described in *Remington's Pharmaceutical Sciences*, 16th ed. 1980, Mack Publishing Company, Easton, PA. In addition, such compositions can  
25 be complexed with polyethylene glycol (PEG), metal ions, or incorporated into polymeric compounds such as polyacetic acid, polyglycolic acid, hydrogels, dextran, etc., or incorporated into liposomes, microemulsions, micelles, unilamellar or multilamellar vesicles, erythrocyte ghosts or spheroblasts. Suitable lipids for liposomal formulation include, without limitation, monoglycerides, diglycerides, sulfatides, lysolecithin, phospholipids, saponin, bile acids, and the like. Preparation of such liposomal  
30 formulations is within the level of skill in the art, as disclosed, for example, in U.S. Pat. No. 4,235,871; U.S. Pat. No. 4,501,728; U.S. Pat. No. 4,837,028; and U.S. Pat. No. 4,737,323. Such compositions will influence the physical state, solubility, stability, rate of *in vivo* release, and rate of *in vivo* clearance, and are thus chosen according to the intended application, so that the characteristics of the carrier will depend on the selected route of administration. In one preferred embodiment of the invention,  
35 sustained-release forms of HPR1 and/or HPR2 polypeptides are used. Sustained-release forms suitable for use in the disclosed methods include, but are not limited to, HPR1 and/or HPR2 polypeptides that are encapsulated in a slowly-dissolving biocompatible polymer (such as the alginate microparticles described in U.S. No. 6,036,978), admixed with such a polymer (including topically applied hydrogels), and or encased in a biocompatible semi-permeable implant.

40 Combinations of Therapeutic Compounds. An HPR1 or HPR2 polypeptide of the present invention may be active in multimers (e.g., heterodimers or homodimers) or complexes with itself or other polypeptides. As a result, pharmaceutical compositions of the invention may comprise a

5 polypeptide of the invention in such multimeric or complexed form. The pharmaceutical composition of the invention may be in the form of a complex of the polypeptide(s) of present invention along with polypeptide or peptide antigens. The invention further includes the administration of HPR1 and/or HPR2 polypeptides or antagonists concurrently with one or more other drugs that are administered to the same patient in combination with the HPR1 and/or HPR2 polypeptides or antagonists, each drug  
10 being administered according to a regimen suitable for that medicament. "Concurrent administration" encompasses simultaneous or sequential treatment with the components of the combination, as well as regimens in which the drugs are alternated, or wherein one component is administered long-term and the other(s) are administered intermittently. Components can be administered in the same or in separate compositions, and by the same or different routes of administration. Examples of components  
15 that can be included in the pharmaceutical composition of the invention are: cytokines, lymphokines, or other hematopoietic factors such as M-CSF, GM-CSF, TNF, IL-1, IL-2, IL-3, IL4, IL-5, IL-6, IL-7, IL-8, IL-9, IL-10, IL-11, IL-12, IL-13, IL-14, IL-15, IL-17, IL-18, IL-23, IFN, TNF0, TNF1, TNF2, G-CSF, Meg-CSF, thrombopoietin, stem cell factor, and erythropoietin. The pharmaceutical composition can further contain other agents which either enhance the activity of the polypeptide or compliment its  
20 activity or use in treatment. Such additional factors and/or agents may be included in the pharmaceutical composition to produce a synergistic effect with polypeptide of the invention, or to minimize side effects. Additional examples of drugs to be administered concurrently include but are not limited to antivirals, antibiotics, analgesics, corticosteroids, antagonists of inflammatory cytokines, non-steroidal anti-inflammatories, pentoxifylline, thalidomide, and disease-modifying antirheumatic  
25 drugs (DMARDs) such as azathioprine, cyclophosphamide, cyclosporine, hydroxychloroquine sulfate, methotrexate, leflunomide, minocycline, penicillamine, sulfasalazine and gold compounds such as oral gold, gold sodium thiomalate, and aurothioglucose. Additionally, HPR1 and/or HPR2 polypeptides or antagonists can be combined with a second HPR1 and/or HPR2 polypeptide/antagonist, including an antibody against an HPR1 and/or HPR2 polypeptide, or an HPR1 polypeptide-derived peptide or HPR2  
30 polypeptide-derived peptide that acts as a competitive inhibitor of native HPR1 and/or HPR2 polypeptides.

Routes of Administration. Any efficacious route of administration may be used to therapeutically administer HPR1 and HPR2 polypeptides or antagonists thereof, including those compositions comprising nucleic acids. Parenteral administration includes injection, for example, via  
35 intra-articular, intravenous, intramuscular, intralesional, intraperitoneal or subcutaneous routes by bolus injection or by continuous infusion., and also includes localized administration, e.g., at a site of disease or injury. Other suitable means of administration include sustained release from implants; aerosol inhalation and/or insufflation.; eyedrops; vaginal or rectal suppositories; buccal preparations; oral preparations, including pills, syrups, lozenges or chewing gum; and topical preparations such as  
40 lotions, gels, sprays, ointments or other suitable techniques. Alternatively, polypeptideaceous HPR1 and HPR2 polypeptides or antagonists may be administered by implanting cultured cells that express the polypeptide, for example, by implanting cells that express HPR1 and/or HPR2 polypeptides or

5 antagonists. Cells may also be cultured *ex vivo* in the presence of polypeptides of the present invention in order to proliferate or to produce a desired effect on or activity in such cells. Treated cells can then be introduced *in vivo* for therapeutic purposes. In another embodiment, the patient's own cells are induced to produce HPR1 and/or HPR2 polypeptides or antagonists by transfection *in vivo* or *ex vivo* with a DNA that encodes HPR1 and/or HPR2 polypeptides or antagonists. This DNA can be  
10 introduced into the patient's cells, for example, by injecting naked DNA or liposome-encapsulated DNA that encodes HPR1 and/or HPR2 polypeptides or antagonists, or by other means of transfection. Nucleic acids of the invention can also be administered to patients by other known methods for introduction of nucleic acid into a cell or organism (including, without limitation, in the form of viral vectors or naked DNA). When HPR1 and/or HPR2 polypeptides or antagonists are administered in  
15 combination with one or more other biologically active compounds, these can be administered by the same or by different routes, and can be administered simultaneously, separately or sequentially.

Oral Administration. When a therapeutically effective amount of polypeptide of the present invention is administered orally, polypeptide of the present invention will be in the form of a tablet, capsule, powder, solution or elixir. When administered in tablet form, the pharmaceutical composition  
20 of the invention can additionally contain a solid carrier such as a gelatin or an adjuvant. The tablet, capsule, and powder contain from about 5 to 95% polypeptide of the present invention, and preferably from about 25 to 90% polypeptide of the present invention. When administered in liquid form, a liquid carrier such as water, petroleum, oils of animal or plant origin such as peanut oil, mineral oil, soybean oil, or sesame oil, or synthetic oils can be added. The liquid form of the pharmaceutical composition  
25 can further contain physiological saline solution, dextrose or other saccharide solution, or glycols such as ethylene glycol, propylene glycol or polyethylene glycol. When administered in liquid form, the pharmaceutical composition contains from about 0.5 to 90% by weight of polypeptide of the present invention, and preferably from about 1 to 50% polypeptide of the present invention.

Intravenous Administration. When a therapeutically effective amount of polypeptide of the present invention is administered by intravenous, cutaneous or subcutaneous injection, polypeptide of the present invention will be in the form of a pyrogen-free, parenterally acceptable aqueous solution. The preparation of such parenterally acceptable polypeptide solutions, having due regard to pH, isotonicity, stability, and the like, is within the skill in the art. A preferred pharmaceutical composition for intravenous, cutaneous, or subcutaneous injection should contain, in addition to polypeptide of the  
35 present invention, an isotonic vehicle such as Sodium Chloride Injection, Ringer's Injection, Dextrose Injection, Dextrose and Sodium Chloride Injection, Lactated Ringer's Injection, or other vehicle as known in the art. The pharmaceutical composition of the present invention can also contain stabilizers, preservatives, buffers, antioxidants, or other additives known to those of skill in the art. The duration of intravenous therapy using the pharmaceutical composition of the present invention will vary,  
40 depending on the severity of the disease being treated and the condition and potential idiosyncratic response of each individual patient. It is contemplated that the duration of each application of the polypeptide of the present invention will be in the range of 12 to 24 hours of continuous intravenous

5 administration. Ultimately the attending physician will decide on the appropriate duration of intravenous therapy using the pharmaceutical composition of the present invention.

Bone and Tissue Administration. For compositions of the present invention which are useful for bone, cartilage, tendon or ligament disorders, the therapeutic method includes administering the composition topically, systematically, or locally as an implant or device. When administered, the  
10 therapeutic composition for use in this invention is, of course, in a pyrogen-free, physiologically acceptable form. Further, the composition can desirably be encapsulated or injected in a viscous form for delivery to the site of bone, cartilage or tissue damage. Topical administration may be suitable for wound healing and tissue repair. Therapeutically useful agents other than a polypeptide of the invention which can also optionally be included in the composition as described above, can  
15 alternatively or additionally, be administered simultaneously or sequentially with the composition in the methods of the invention. Preferably for bone and/or cartilage formation, the composition would include a matrix capable of delivering the polypeptide-containing composition to the site of bone and/or cartilage damage, providing a structure for the developing bone and cartilage and optimally capable of being resorbed into the body. Such matrices can be formed of materials presently in use for  
20 other implanted medical applications. The choice of matrix material is based on biocompatibility, biodegradability, mechanical properties, cosmetic appearance and interface properties. The particular application of the compositions will define the appropriate formulation. Potential matrices for the compositions can be biodegradable and chemically defined calcium sulfate, tricalciumphosphate, hydroxyapatite, polylactic acid, polyglycolic acid and polyanhydrides. Other potential materials are  
25 biodegradable and biologically well-defined, such as bone or dermal collagen. Further matrices are comprised of pure polypeptides or extracellular matrix components. Other potential matrices are nonbiodegradable and chemically defined, such as sintered hydroxapatite, bioglass, aluminates, or other ceramics. Matrices can be comprised of combinations of any of the above mentioned types of material, such as polylactic acid and hydroxyapatite or collagen and tricalciumphosphate. Presently preferred is a 50:50 (mole weight) copolymer of lactic acid and glycolic acid in the form of porous particles having diameters ranging from 150 to 800 microns. In some applications, it will be useful to utilize a sequestering agent, such as carboxymethyl cellulose or autologous blood clot, to prevent the polypeptide compositions from disassociating from the matrix. A preferred family of sequestering agents is cellulosic materials such as alkylcelluloses, the most preferred being cationic salts of  
35 carboxymethylcellulose (CMC). Other preferred sequestering agents include hyaluronic acid, sodium alginate, poly(ethylene glycol), polyoxyethylene oxide, carboxyvinyl polymer and poly(vinyl alcohol). The amount of sequestering agent useful herein is 0.5-20 wt %, preferably 1-10 wt % based on total formulation weight, which represents the amount necessary to prevent desorption of the polypeptide from the polymer matrix and to provide appropriate handling of the composition, yet not so much that  
40 the progenitor cells are prevented from infiltrating the matrix, thereby providing the polypeptide the opportunity to assist the osteogenic activity of the progenitor cells. In further compositions, polypeptides of the invention can be combined with other agents beneficial to the treatment of the bone

5 and/or cartilage defect, wound, or tissue in question. Progress can be monitored by periodic assessment of tissue/bone growth and/or repair, for example, X-rays, histomorphometric determinations and tetracycline labeling.

Veterinary Uses. In addition to human patients, HPR1 and HPR2 polypeptides and antagonists are useful in the treatment of disease conditions in non-human animals, such as pets (dogs, cats, birds, primates, etc.), domestic farm animals (horses cattle, sheep, pigs, birds, etc.), or any animal that suffers from a TNF $\alpha$ -mediated inflammatory or arthritic condition. In such instances, an appropriate dose can be determined according to the animal's body weight. For example, a dose of 0.2-1 mg/kg may be used. Alternatively, the dose is determined according to the animal's surface area, an exemplary dose ranging from 0.1-20 mg/m<sup>2</sup>, or more preferably, from 5-12 mg/m<sup>2</sup>. For small animals, such as dogs or cats, a suitable dose is 0.4 mg/kg. In a preferred embodiment, HPR1 and/or HPR2 polypeptides or antagonists (preferably constructed from genes derived from the same species as the patient), are administered by injection or other suitable route one or more times per week until the animal's condition is improved, or they can be administered indefinitely.

Manufacture of Medicaments. The present invention also relates to the use of HPR1 and HPR2 polypeptides, fragments, and variants; nucleic acids encoding the HPR1 or HPR2 polypeptides, fragments, and variants; agonists or antagonists of the HPR1 and/or HPR2 polypeptides such as antibodies; HPR1 and/or HPR2 polypeptide binding partners; complexes formed from the HPR1 and/or HPR2 polypeptides, fragments, variants, and binding partners, etc, in the manufacture of a medicament for the prevention or therapeutic treatment of each medical disorder disclosed herein.

## 25 EXAMPLES

The following examples are intended to illustrate particular embodiments and not to limit the scope of the invention.

### EXAMPLE 1

#### 30 **A. Identification of HPR1, a New Member of the Human Hematopoietin Receptor Family**

A data set was received from Celera Genomics (Rockville, Maryland) containing a listing of amino acid sequences predicted to be encoded by the human genome. This data set was searched with a BLAST algorithm to identify hematopoietin receptor family polypeptides. Several amino acid sequences, including two overlapping amino acid sequences (SEQ ID NO: 1 and SEQ ID NO:2), were identified as comprising partial amino acid sequences of a new human hematopoietin receptor polypeptide, HPR1. These amino acids sequences were used to identify a DNA sequence (SEQ ID NO:3) encoding an HPR1 polypeptide having the amino acid sequence shown in SEQ ID NO:4; nucleotides 132 through 2366 of SEQ ID NO:3 encode SEQ ID NO:4, with nucleotides 2367 through 2369 corresponding to a stop codon. The HPR1 coding sequence (nucleotides 132 through 2369 of SEQ ID NO:3) is presented as SEQ ID NO:5. The HPR1 sequences of SEQ ID NOs 3 and 5 were confirmed by three independent PCR amplification experiments from a U937 cDNA library. These HPR1 coding sequences were compared with publicly available preliminary human genomic DNA sequences, and the following chromosome 5 contigs were identified as containing HPR1 coding sequences: AC022265.3, AC008914.3, AC008857.4, and AC016596.4. The human genomic region



5 corresponding to these contigs also includes the gene for gp130, which suggests that gp130 and HPR1 may derive from a common ancestral gene by gene duplication. The approximate positions of the exons containing HPR1 coding sequence in the AC022265.3 contig are shown in the table below, along with their locations relative to SEQ ID NOs 3 and 5; note that the 5' and 3' untranslated regions may extend further along the contig sequence beyond those portions that correspond to SEQ ID NOs 3 and 10 5, as indicated by the parentheses around the AC022265.3 endpoints in the table. Due to the preliminary sequence and assembly of the contig sequence, the exons within the contig are not always in the right order or orientation with respect to each other, and may contain sequence variations due to inaccurate sequence data or allelic polymorphism.

Corresponding positions of HPR1 gene exons in human contig AC022265.3 and in cDNA sequences:

	Position in AC022265.3	Position in SEQ ID NO:3 / Position in SEQ ID NO:5
Exon 1	(128423)-128559	1-137 / 1-6
Exon 2	134501-134591	138-228 / 7-97
Exon 3	143777-143894	229-346 / 98-215
Exon 4	147256-147437	347-528 / 216-397
Exon 5	51249-51098	529-680 / 398-549
Exon 6	44322-44157	681-846 / 550-715
Exon 7	16473-16394	847-926 / 716-795
Exon 8	30331-30115	927-1143 / 796-1012
Exon 9	178626-178808	1144-1326 / 1013-1195
Exon 10	179879-179980	1327-1428 / 1196-1297
Exon 11	180785-180931	1429-1575 / 1298-1444
Exon 12	183052-183192	1576-1716 / 1445-1585
Exon 13	185997-186090	1717-1810 / 1586-1679
Exon 14	187367-187448	1811-1892 / 1680-1761
Exon 15	189165-(189747)	1893-2480 / 1762-2238

15 A nucleic acid encoding a polypeptide with a high degree of amino acid similarity (approximately 61% amino acid identity) to human HPR1 was isolated from *Mus musculus*. The *Mus* HPR1 amino acid sequence is presented as SEQ ID NO:12, and due to its high level of similarity with human HPR1, is considered to be the murine homologue of human HPR1. PCR amplification of cDNA sequences corresponding to mRNAs encoding murine HPR1 identified a cDNA molecule 20 encoding SEQ ID NO:12; the nucleotide sequence of this murine HPR1 cDNA is presented as SEQ ID NO:28. Nucleotides 1 through 2178 of SEQ ID NO:28 encode SEQ ID NO:12, with nucleotides 2179-2181 corresponding to a stop codon. Variants of the murine HPR1 amino acid sequence that are likely allelic variants have been identified in which the 'T' residue at position 121 of SEQ ID NO:28 is changed to a 'C' residue, resulting in a change from the Phe residue at position 41 of SEQ ID NO:4 to a 25 Leu residue, and in which the 'G' residue at position 1666 of SEQ ID NO:28 is changed to an 'A' residue, resulting in a change from the Asp residue at position 556 of SEQ ID NO:4 to an Asn residue.

Several splice variations of the HPR1 sequences have been identified in human genomic sequences and are included within the scope of the invention. For example, amino acids 1 through 55 of SEQ ID NO:1 match the amino acid sequence of HPR1 presented in SEQ ID NO:4, while amino

5 acids 56 through 77 of SEQ ID NO:1 may be a portion of an alternatively spliced exon added following the exon/intron boundary identified between nucleotides 846 and 847 of SEQ ID NO:3 (nucleotides 715 and 716 of SEQ ID NO:5). In an additional potential splice variant, an amino acid sequence ending in the amino acids of SEQ ID NO:10 could be substituted for the amino acids leading up to and including the lysine at position 190 of SEQ ID NO:4. However, such a splice variant would require an additional exon/intron boundary approximately between nucleotides 701 and 702 of SEQ ID NO:3 (nucleotides 570 and 571 of SEQ ID NO:5). In a further potential splice variant, the amino acid sequence of SEQ ID NO:11 could be substituted for amino acids 238 through 266 of SEQ ID NO:4 by replacing exon 7 with an alternative exon encoding the SEQ ID NO:11 amino acids. In this potential variant, 29 amino acids C-terminal to the WSXWS motif and including the N-terminal portion of the most N-terminal fibronectin type III repeat (as shown in Table 1) would be replaced with 15 amino acids, resulting in deletion of a portion of the most N-terminal fibronectin type III repeat, including two highly conserved Trp residues.

Additional variations of HPR1 polypeptides are provided as naturally occurring genomic variants of the HPR1 sequences disclosed herein; such variations may be incorporated into an HPR1 polypeptide or nucleic acid individually or in any combination, or in combination with alternative splice variation as described above. As one example, amino acids 5 through 40 of SEQ ID NO:2 match SEQ ID NO:4, with amino acid 4 of SEQ ID NO:2 likely representing an allelic variation, where the change from the Asn residue position 187 of SEQ ID NO:4 to a Thr residue in SEQ ID NO:2 could be caused by a single change from 'A' to 'C' at position 691 of SEQ ID NO:3 or 560 of SEQ ID NO:5. This variation and others are listed in the table below:

Amino Acid Change	Position in SEQ ID NO:4	Nucleotide Change	Position in SEQ ID NO:3 / Position in SEQ ID NO:5
Thr -> Ala	83	A -> G	378 / 247
Asp -> Asn	168	G -> A	633 / 502
Asn -> Thr	187	A -> C	691 / 560
Ser -> Pro	361	T -> C	1212 / 1081
Ala -> Gly	362	C -> G	1216 / 1085
Ser -> Asn	510	G -> A	1660 / 1529
Asn -> Asp	517	A -> G	1680 / 1549
Arg -> Gly	679	A -> G	2166 / 2035

#### **B. Identification of HPR2, a New Member of the Human Hematopoietin Receptor Family**

A data set was received from Celera Genomics (Rockville, Maryland) containing a listing of amino acid sequences predicted to be encoded by the human genome. This data set was searched with a BLAST algorithm to identify hematopoietin receptor family polypeptides. Several amino acid sequences, including SEQ ID NO:16, were identified as comprising partial amino acid sequences of a new human hematopoietin receptor polypeptide, HPR2. These amino acids sequences were used to identify a DNA sequence (SEQ ID NO:19) encoding an HPR2 polypeptide having the amino acid sequence shown in SEQ ID NO:21; nucleotides 107 through 1993 of SEQ ID 19 encode SEQ ID

5 NO:21, with nucleotides 1994 through 1996 corresponding to a stop codon. The HPR2 coding sequence (nucleotides 107 through 1996 of SEQ ID NO:19) is presented as SEQ ID NO:20. The HPR2 sequences of SEQ ID NOs 19 and 20 were confirmed by independent PCR amplification experiments from a human lymph node cDNA library and a CB23 B cell line cDNA library. These PCR amplification experiments also identified two additional splice variants of the HPR2 cDNA sequence referred to as HPR2-ex8-ex9 and HPR2-ex9; the coding sequences for HPR2-ex8-ex9 and HPR2-ex9 are presented as SEQ ID NOs 22 and 24, respectively, and the amino acid sequences they encode are presented as SEQ ID NOs 23 and 25, respectively. The HPR2 cDNA sequences of SEQ ID NOs 19, 20, and the HPR2-ex8-ex9 cDNA of SEQ ID NO:22 were present in both the lymph node and CB23 cDNA libraries, while the HPR2-ex9 cDNA of SEQ ID NO:24 was only present in the lymph node library.

These HPR2 coding sequences were compared with publicly available preliminary human genomic DNA sequences, and the following chromosome 1 contigs were identified as containing HPR2 coding sequences: GenBank accession numbers AL109843 (1p31.2-32.1) and AL389925. The human genomic region corresponding to the AL389925 contig also includes the gene for IL-12RB2, which suggests that IL-12RB2 and HPR2 may derive from a common ancestral gene by gene duplication. The approximate positions of the exons containing HPR2 coding sequence in the AL109843 and AL389925 contigs are shown in the table below, along with their locations relative to SEQ ID NOs 19, 20, 22, and 24; note that the 5' and 3' untranslated regions may extend further along the contig sequence beyond those portions that correspond to SEQ ID NOs 19, 20, 22, and 24, as indicated by the parentheses around the AL109843 and AL389925 endpoints in the table. Due to the preliminary nature of the sequence data and assembly of the contig sequence, the exons within the genomic contigs may contain sequence variations due to inaccurate sequence data or allelic polymorphism.

Corresponding positions of HPR2 gene exons in human genomic contigs AL109843 and AL389925 and in HPR2 coding sequences:

	Position in AL109843	Position in SEQ ID NO:19 / 20 / 22 / 24
Exon 1	(34088)-34164	1-77 / (5' UTR, not in SEQ ID NOs 20, 22, and 24)
Exon 2	35715-35813	78-176 / 1-70 / 1-70 / 1-70
Exon 3	36965-37261	177-473 / 71-367 / 71-367 / 71-367
Exon 4	50459-50582	474-597 / 368-491 / 368-491 / 368-491
Exon 5	68360-68520	598-758 / 492-652 / 492-652 / 492-652
Exon 6	74533-74678	759-904 / 653-798 / 653-798 / 653-798
Exon 7	87197-87353	905-1061 / 799-955 / 799-955 / 799-955
Exon 8	104336-104425	1062-1151 / 956-1045 / (not present) / 956-1045
Exon 9	107802-107904	1152-1254 / 1046-1148 / (not present) / (not present)
	Position in AL389925	Position in SEQ ID NO:19 / 20 / 22 / 24
Exon 10	8847-8937	1255-1345 / 1149-1239 / 'G'-957-1047 / 1046-1071
Exon 11	11488-(12972)	1346-2830 / 1240-1890 / 1048-1698 / (not present)

In the HPR3-ex9 splice variant, note that the absence of the exon 9 sequence (103 nucleotides) changes the reading frame towards the 3' end of the coding sequence for the HPR2-ex9 form (SEQ ID NO:24)

5 relative to that of the HPR2 coding sequence of SEQ ID NO:20, leading to a different amino acid sequence in the HPR2-ex9 C-terminal portion and a stop codon after amino acid 356 (compared to 629 amino acids in HPR2). For the HPR2-ex8-ex9 form, the splice is made at a slightly different exon 10 splice acceptor site than for the HPR2 form, so that an extra 'G' residue is included at the start of exon 10 in the HPR2-ex8-ex9 form, restoring the reading frame to be the same as in the 3' end of the HPR2  
10 sequence. The C-terminal 248 amino acids of HPR2-ex8-ex9 form are therefore the same as the C-terminal 248 amino acids of HPR2 form, and although the coding sequence of the HPR2-ex8-ex9 form is missing both exons 8 and 9 (except for the last 'G' residue of exon 9), the resulting HPR2-ex8-ex9 form polypeptide is longer (565 amino acids) than the HPR2-ex9 form polypeptide (356 amino acids).

Several splice variations of the HPR2 sequences have been identified in human genomic  
15 sequences and are included within the scope of the invention. For example, amino acids 118 through 215 of SEQ ID NO:16 match the amino acid sequence of HPR2 presented in SEQ ID NO:21, while amino acids 1 through 117 of SEQ ID NO:16 may correspond to an alternatively spliced exon added upstream of exon 3 (i.e. at the exon/intron boundary identified between nucleotides 176 and 177 of SEQ ID NO:19). Amino acids 216 through 245 of SEQ ID NO:16 may correspond to an additional  
20 alternatively spliced exon added between exon 3 and exon 4 (i.e. at the exon/intron boundary identified between nucleotides 473 and 474 of SEQ ID NO:19). Amino acids 340 through 344 of SEQ ID NO:16 may correspond to an alternatively spliced exon added downstream of exon 5 (i.e. at the exon/intron boundary identified between nucleotides 758 and 759 of SEQ ID NO:19). In a further potential splice variant, an alternative exon or exons encoding the amino acid sequence of SEQ ID NO:17 could be  
25 substituted for exon 6, resulting in the replacement of amino acids 217 through 267 of SEQ ID NO:21 with the SEQ ID NO:17 amino acids. In this potential variant, 51 amino acids N-terminal to the WSXWS motif, including the proline-rich region (as shown in Table 1) between the two cytokine receptor subdomains, would be replaced with 39 amino acids, resulting in deletion of a portion of the more C-terminal cytokine receptor subdomain which includes a highly conserved Trp residue. In an  
30 additional potential splice variant, an alternative exon could be added downstream of exon 4 (i.e. at the exon/intron boundary identified between nucleotides 597 and 598 of SEQ ID NO:19) so that an amino acid sequence starting in the amino acids of SEQ ID NO:18 could be substituted for amino acids following and including the serine at position 164 of SEQ ID NO:21. Multiple splice variations as described above can be included in a single splice variant, for example, replacing exon 6 with an  
35 alternative exon or exons encoding the amino acid sequence of SEQ ID NO:17, and also deleting exons 8 and/or 9 as described above.

Additional variations of HPR2 polypeptides are provided as naturally occurring genomic variants of the HPR2 sequences disclosed herein; such variations may be incorporated into an HPR2 polypeptide or nucleic acid individually or in any combination, or in combination with alternative  
40 splice variation as described above. As one example, a change from the Leu residue position 310 of SEQ ID NO:21 to a Pro residue could be caused by a single change from 'T' to 'C' at position 1035 of SEQ ID NO:19. This variation and another are listed in the table below:

Amino Acid Change	Position in SEQ ID NO:21	Nucleotide Change	Position in SEQ ID NO:19
Leu->Pro	310	T->C	1035
(not applicable)	(not applicable)	A->G	2172 (3' UTR)

5

A nucleic acid encoding a polypeptide with a high degree of amino acid similarity (approximately 69% amino acid identity) to human HPR2 was isolated from *Mus musculus*. The *Mus* HPR2 amino acid sequence is presented as SEQ ID NO:27, and due to its high level of similarity with human HPR2, is considered to be the murine homologue of human HPR2. PCR amplification of cDNA sequences corresponding to mRNAs encoding murine HPR2 identified a cDNA molecule encoding SEQ ID NO:27; the nucleotide sequence of this murine HPR2 cDNA is presented as SEQ ID NO:29. Nucleotides 1 through 1932 of SEQ ID NO:29 encode SEQ ID NO:27, with nucleotides 1933-1935 corresponding to a stop codon. The murine HPR2 amino acid sequence of SEQ ID NO:27 appears to have a 20-amino acid insertion at amino acids 297 through 316 of SEQ ID NO:27 relative to human HPR2 of SEQ ID NO:21, based on an alignment of the human and murine polypeptide sequences; this insertion is identical to amino acids 317 through 336. Given the number of alternatively spliced forms identified for human HPR2, it is possible that this insertion in murine HPR2 relative to the human HPR2 of SEQ ID NO:21 is the result of alternative splicing. One embodiment of the invention is a form of murine HPR2 in which one of these repeated WQPWS-containing motifs has been deleted; that is, polypeptides in which the amino acid sequence ending with amino acid 296 of SEQ ID NO:27 is contiguous with the amino acid sequence beginning with amino acid 317 of SEQ ID NO:27, or polypeptides in which the amino acid sequence ending with amino acid 316 of SEQ ID NO:27 is contiguous with the amino acid sequence beginning with amino acid 337 of SEQ ID NO:27.

#### 25 C. Comparison of HPR1 and HPR2 to Other Hematopoietin Receptor Polypeptides.

The amino acid sequences of human HPR1 (SEQ ID NO:4), murine HPR1 (SEQ ID NO:12), and human HPR2 (SEQ ID NO:21) were compared with the amino acid sequences of these other hematopoietin receptor family members - LIF-R, the interleukin 12 beta 2 receptor chain (IL-12RB2), gp130, and GCSFR (SEQ ID NO:6 - SEQ ID NO:9, respectively) - using the GCG "pretty" multiple sequence alignment program, with amino acid similarity scoring matrix = blosum62, gap creation penalty = 8, and gap extension penalty = 2. Alignments of these sequences are shown in Table 1, and include consensus residues which are identical among at least three of the amino acid sequences in the alignment. The capitalized residues in the alignment are those which match the consensus residues. The numbering of amino acid residues in Table 1 corresponds to the position of those residues in the HPR1 amino acid sequence (SEQ ID NO:4). Note that only a portion of the HPR2 amino acid sequence is shown in Table 1, as HPR2 does not contain fibronectin type III repeats in its extracellular domain. HPR1 and HPR2 sequences corresponding to the intracellular Box 1 and Box 2 motifs are shown in Table 2. Sequences of eleven amino acids similar to the Box 1 or 2 motif of other hematopoietin receptors were identified for HPR1 and HPR2, and placed into a column with these motif sequences (with no gaps introduced). Similarly, HPR2 sequences corresponding to the

35

5 intracellular Box 3 motif are shown in Table 3. Sequences of fourteen amino acids similar to the Box 3 motif of other hematopoietin receptors were identified for HPR2, and placed into a column with these motif sequences (with no gaps introduced). The numbering of each sequence on Tables 2 and 3 corresponds to their position in the complete amino acid sequence for that HPR polypeptide. The consensus residues are those that are present in three or more (for Table 2) or two or more (for Table 3) sequences at that position in the motif.

Amino acid substitutions and other alterations (deletions, insertions, etc.) to HPR1 and HPR2 amino acid sequences (for example, SEQ ID NOs 4, 12, and 21) are predicted to be more likely to alter or disrupt HPR1 or HPR2 polypeptide activities if they result in changes to the capitalized residues of the amino acid sequences as shown in Tables 1, 2, and 3, and particularly if those changes do not substitute an amino acid of similar structure (such as substitution of any one of the aliphatic residues - Ala, Gly, Leu, Ile, or Val - for another aliphatic residue), or a residue present in other hematopoietin receptor polypeptides at that conserved position. Conversely, if a change is made to an HPR1 or HPR2 amino acid sequence resulting in substitution of the residue at that position in the alignment from one of the other Table 1, 2, or 3 hematopoietin receptor polypeptide sequences, it is less likely that such an alteration will affect the function of the altered HPR1 or HPR2 polypeptide. For example, the consensus residue at position 42 in Table 1 is serine, and one of the hematopoietin receptors (LIF-R) has an asparagine at that position. Substitution of asparagine or the chemically similar glutamine for serine at that position is considered to be less likely to alter the function of the polypeptide than substitution of tryptophan or tyrosine etc. Embodiments of the invention include HPR1 and HPR2 polypeptides and fragments of HPR1 and HPR2 polypeptides, comprising altered amino acid sequences. Altered HPR1 or HPR2 polypeptide sequences share at least 30%, or more preferably at least 40%, or more preferably at least 50%, or more preferably at least 55%, or more preferably at least 60%, or more preferably at least 65%, or more preferably at least 70%, or more preferably at least 75%, or more preferably at least 80%, or more preferably at least 85%, or more preferably at least 90%, or more preferably at least 95%, or more preferably at least 97.5%, or more preferably at least 99%, or most preferably at least 99.5% amino acid identity with one or more of the hematopoietin receptor amino acid sequences shown in Tables 1, 2, and 3.

**Table 1: Alignment of HPR1 and HPR2 extracellular domains with those of other hematopoietin receptors**

35 C : conserved cysteine  
 ■■■ : proline-rich 'linker' between cytokine receptor subdomains  
 ■■■ : WSXWS motif  
 ■■■ : fibronectin type III repeats  
 ■■■ : transmembrane domain

	SEQ ID NO:		78
	35		
Hs HPR1	4	PaKPeNiSCV yYyr.KNLTC TWsPGkETs. ....yTqYTv KrtyafGekh	
Mus HPR1	12	PtKPeNiSCV fYfd.rNLTC TWrPekETn. ....dTSYiv tltySyGK..	
gp130	8	PeKPkNLSCi vneg.Kkmc eWdgGrETHL ....eTnftL KsewathKfa	
GCSFR	9	PaiPhNLSCl mnlTtssLiC qWePGpETHL ....pTSfTL KsfkSrGnCq	
Hs HPR2	21	PdiPdevtCV iYeysgNmTC TWnaGklTyi ....dTkYvv hv.....Ksl	

IL-12RB2	7	PeqPqNLSCi qkgeggatvaC TWerGrdTHL ...yTeYTL ql..SgpKnl
LIF-R	6	PdtPqgLnCe th.dlKeiiC sWnPGrvTaL vgpraTSYTL vesfs.GKyv
consensus		P-KP-NLSCV -Y---KNLTC TW-PG-ETHL -----TSYTL K---S-GK--
		79 126
Hs HPR1	4	dnCttnssts enrasCsffl PRiti..pdN YtieVeAENG dGvikShmtY
Mus HPR1	12	.....snys dnateasysf PRscampdi csVeVQAqNg dGkvkSdity
gp130	8	dCkagr.... dtptsCtvdY stvyfv...N ieVWVeAENA LGkvtSdhin
GCSFR	9	tqgdsildcv pkdggshCci PRkhlllyqN mgiVWQAENA LGtSmSpqLc
Hs HPR2	21	eteeegqyLt ssY....ini stdslgggk YlVWVQAaNA LGmeeSkqLq
IL-12RB2	7	twqkgCkdiY CdYldfginL tpespe..sN ftakVtAvNs LGsSsSlpst
LIF-R	6	rlkraeaptn esYqllfqmL Pnqei..... YnftlnAhNp LGrSqStiL.
consensus		----- --Y-----L PR-----N Y-VWVQAENA LG-S-S--L-
		127 172
Hs HPR1	4	wrLenIaKtE PPkIfRVKpV lgi....krm iQieWikPel apvssdLKyt
Mus HPR1	12	whLisIaKtE PPiilsVnPI ..c....nrm fQiqW.kPre ktrgfpLvCm
gp130	8	fdpvykVKPn PPnlsVins eel....ssi lKlTWtnPsi ksv.IiLKyn
GCSFR	9	ldpmDvVKlE PPmlrtmdPs peaappgagc lQLcW.ePwq pglhIngKCE
Hs HPR2	21	ihLdDIViPs aavIsRaeti natvpkti...iyWds... qttiekvsCE
IL-12RB2	7	ftfLDIVrPl PPwdiRikfQ kasvsrct...LyWrd... eglv..Llnr
LIF-R	6	vnitekVyPh tPtsfkVKdI nsta..... vkLsWhlPg. nfakInflCE
consensus		--L-DIVKPE PP-I-RVKPI ----- -QL-W--P-- ----I-LKCE
		173 221
Hs HPR1	4	LrFRTvNS.t sWmeVnFakN rkdknqtynL tGLqPFTEYV ialRCavkes
Mus HPR1	12	LrFRTvNS.s rWteVnF.eN ck...qvcnL tGLqaFTEYV ialRfrfnds
gp130	8	iqYRTkda.s tWsqip.ped tastrssftv qdLkPFTEYV FrIRCmkEdg
GCSFR	9	LRhkpqrgea sWalVg...p lplealqyeL cGLlPaTaYt lQIRCirwpl
Hs HPR2	21	mRYkattngt .WnvkeF..d tnftyvqgse fyLePnikYV FQvRCq.Etg
IL-12RB2	7	LRYRpsNSrl .Wnm..v..N vtkakgrhdL ldLkPFTEYE FQIssklhly
LIF-R	6	ieikksNSvq egrnVti.kg venssylvaL dkLnPyTlyt FrIRCstEtf
consensus		LRYRT-NS-- -W--V-F--N -----L -GL-PFTEYV FQIRC--E--
		222 261
Hs HPR1	4	K.fWSDWSqE kmgmTeEEaP c.....gLe lW...RvLkP aeadGrRpVr
Mus HPR1	12	r.YWSkWSkE etrvTmEEvP h.....vLD lW...RiLeP admnGdRkVr
gp130	8	KGYWSDWSeE asgiTyEdrP sk.....aps fW...ykiDP shtgGyRtVq
GCSFR	9	pGhWSDWSps lelrtTeraP tv.....rLD TWwrgRqLDP .....RtVq
Hs HPR2	21	KrYWqpWSsl ffhkTpEtvp qvtskafqhD TWns~~~~~
IL-12RB2	7	KGsWSDWSes lragTpEEeP ..tgml...D vWymkRhiD. ...ysrqgis
LIF-R	6	.wkWSkWSnk qghlTtEasP sk.....gpD TWrew..... ssdgnli
consensus		KGYWSDWS-E ----T-EE-P -----LD TW---R-LDP ----G-R-V-
		262 310
Hs HPR1	4	LlWKkargap vleKtLGYni wyypesnTn. LTETmNtTnq qlelhLgges
Mus HPR1	12	LlWKkargap vleKtFGYhi qyfaensTn. LTEinNiTtg qvellLmsga
gp130	8	LvWKtLPpfe AnGKILdYeV tltrwkshl. gnytvNaT.. kltvnLtnr
GCSFR	9	LfWKpvPleE dsGrIqGYvV swrpsggaga ilplcNtTel sctfhLpsea
IL-12RB2	7	LfWKnLsvsE ArGKILhYqV tlqeltggka mTqnitghts wttviprtgn
LIF-R	6	iyWKpLPine AnGKILsYnV scssdeeTqs LsEipd.pgh kaeirLdknd
consensus		L-WK-LP--E A-GKILGY-V -----T-- LTE--N-T-- ----L----
		311 359
Hs HPR1	4	fwVSmisyNS lGKSpatLr IPaiqEksfq cievmaqAcva ed.qLvVkWQ
Mus HPR1	12	hsVSVtsfNS lGKSqeTiLr IPdvhEktfq yiksmqAyia ep.lLvVnWQ
gp130	8	ylatltvrNl vGKSdaavLt IPacdfgath pvmdlkAfpk dn.mLwVeWt
GCSFR	9	qeValvAyNS aGtSrPTpv. .vfsEsrgp altrlhAmar dphsLwVgWe
IL-12RB2	7	waVaVsAaNS kGsSlPTrin ImnlcEagll aprqvsAnse gmdniltWQ
LIF-R	6	yisSVvAkNS vGsSpPskia smeipnddl. ...kieqvvg mgkgilltWh
consensus		--VSV-A-NS -GKS-PT-L- IP---E---- ----A--- ----L-V-WQ

		360	404
Hs HPR1	4	ssal...dVn twmIEWfpdv d.SePttsW e.svSqaTnw TiggDkLKPF	
Mus HPR1	12	ssip...aVd twivEWlpea amSkfpalsW e.svSqvTnw TIEgDkLKPF	
gp130	8	tPre...sVk kYileWcvls dka.PcitdW q.gedgtvhr TyIrgNLaes	
GCSFR	9	pPnp...wpg gYVIEWglgp psasnsnktW rmegnratg flIkeNirPF	
IL-12RB2	7	pPrkdpsaVq eYVvEWrelh pggdtqvpln wlrsrpyvns aliseNiKsy	
LIF-R	6	...ydpnmtc dYVIkwc.ns srSePclmdW rkvpSnsTet vIesDefrPg	
consensus		-P-----V- -YVIEW---- --S-P----W ----S--T-- TI--DNLKPF	
		405	454
Hs HPR1	4	wCYNIsVYPm lhDkvGePyS IqAYaKEgvP SeGPetkVEN IGvktvtItW	
Mus HPR1	12	tCYNIsVYPv lghrvGePyS IqAYaKEgtP lkGPetrVEN IGlrtAtItW	
gp130	8	kCYlItVtPv yaDgpGsPeS IkAYlKgapP SkGPTvrtkk vGKneAvleW	
GCSFR	9	qlYeIiVtPl yqDtmGpsqh vyAYSqEmAP ShaPElhkh IGKtwaGleW	
IL-12RB2	7	iCYeIrVYal sgDq.GgcSS IlgnsKhkAP lsGPhinait eeKgsilIsW	
LIF-R	6	irYNfflygc rnggyqlrS migYieElAP ivaPnftVED tsadsilvkW	
consensus		-CYNI-VYP- --D--G-P-S I-AY-KE-AP S-GPE--VE- IGK--A-I-W	
		455	489
Hs HPR1	4	keIPksErkG iicNYTIFYq aeGGkgfSKt .....VN....SSi	
Mus HPR1	12	keIPksarnG FinNYTvFYq aeGGkelSKt .....VN....Sha	
gp130	8	dqlPVdvqnG FirNYTIFYr tiiGnetavn .....Vd....SSh	
GCSFR	9	vpePpelgks plthYTIFwt nagngsfSai .....lN....aSS	
IL-12RB2	7	nsIPVqEqmG clIhYrIywk erdsnsqpgl .....ceipyrvSq	
LIF-R	6	edIPVeElrG FlrgY.lfYf gkGerdtSKm rvlesgrsdi kVknitdiSq	
consensus		--IPV-E--G F--NYTIFY- --GG---SK- -----VN----SS-	
		490	539
Hs HPR1	4	lqygLeSLkr kTSYiVqvMA sTsAGGTNGt sinFkTLsfS VfEIilItsL	
Mus HPR1	12	lqcdLeSLtr rTSYtVwvMA sTrAGGTNGv rinFkTLsiS VfEvllItsL	
gp130	8	teytLsSLts dTlYmVrmaA yTdeGGkdGp eftFtTpka ggeIEaIvvp	
GCSFR	9	rgfvLhgLep aslyYhihMA asqAGaTNst vltlmTLtpe gsElhiIlgl	
IL-12RB2	7	nshpinSLqp rvtYvlwmtA lTaAGesshg nerefcLgqk anwmafavaps	
LIF-R	6	ktlriadLgg kTSYhlvlrA yTdGvggpek smyvvtkenS VglIiaIlip	
consensus		----L-SL-- -TSY-V--MA -T-AGGTNG- ---F-TL--S V-EI--I--L	

5

**Table 2: Box 1 and Box 2 motifs in the intracellular domains of HPR1, HPR2, and other hematopoietin receptors**

	SEQ ID NO	Box 1 Motif	Box 2 Motif
Hs HPR1	4	563-thlcWPtVNP-573	631-eifTdEArtgq-641
Mus HPR1	12	517-tpIccPDVNP-527	582-VvlTEEAqKgq-592
HPR2	21	393-pkwlyeDiPNm-403	430-VdpmiteiKei-440
LIF-R	6	866-KetfyPDiPNP-876	910-VleTrsAfpKi-920
gp130	8	648-KkhiWPnVPdP-658	693-VveiEandKKp-703
GCSFR	9	655-KnplWPsVPdP-665	696-ltvIEEdeKKp-706
consensus		K---WPDVNP	V--TEEA-KK-

**Table 3: Box 3 motifs in the intracellular domains of HPR2 and other hematopoietin receptors**

	SEQ ID NO	Box 3 Motif
HPR2 (first occurrence)	21	478-PdLntGYKPQisnf-491
HPR2 (second occurrence)	21	605-lpsintYfPQniLe-618
LIF-R	6	995-PVggaGYKPQmhlP-1008
gp130	8	693-tVvhsGYrhQvpsv-774
GCSFR	9	696-PtLvgtYvlQgdpr-734
consensus residues		PVL--GYKPQ--L-



5

**EXAMPLE 2: Monoclonal Antibodies That Bind Polypeptides of the Invention**

This example illustrates a method for preparing monoclonal antibodies that bind HPR1 or HPR2 polypeptides. Suitable immunogens that may be employed in generating such antibodies include, but are not limited to, purified HPR1 or HPR2 polypeptide or an immunogenic fragment thereof. Purified HPR1 or HPR2 polypeptide can be used to generate monoclonal antibodies immunoreactive therewith, using conventional techniques such as those described in U.S. Patent 4,411,993. Briefly, mice are immunized with HPR1 or HPR2 polypeptide immunogen emulsified in complete Freund's adjuvant, and injected in amounts ranging from about 10 to about 100 micrograms subcutaneously or intraperitoneally. Ten to twelve days later, the immunized animals are boosted with additional HPR1 or HPR2 polypeptide emulsified in incomplete Freund's adjuvant. Mice are periodically boosted thereafter on a weekly to bi-weekly immunization schedule. Serum samples are periodically taken by retro-orbital bleeding or tail-tip excision to test for anti-HPR1 or anti-HPR2 antibodies by dot blot assay, ELISA (Enzyme-Linked Immunosorbent Assay), or inhibition of binding of HPR1 or HPR2 polypeptide to an HPR1 and/or HPR2 binding partner.

Following detection of an appropriate antibody titer, positive animals are provided one last intravenous injection of HPR1 or HPR2 polypeptide in saline. Three to four days later, the animals are sacrificed, spleen cells harvested, and spleen cells are fused to a murine myeloma cell line, *e.g.*, NS1 or preferably P3x63Ag8.653 (ATCC CRL 1580). Fusions generate hybridoma cells, which are plated in multiple microtiter plates in a HAT (hypoxanthine, aminopterin and thymidine) selective medium to inhibit proliferation of non-fused cells, myeloma hybrids, and spleen cell hybrids.

The hybridoma cells are screened by ELISA for reactivity against purified HPR1 or HPR2 polypeptide by adaptations of the techniques disclosed in Engvall et al., (*Immunochem.* 8:871, 1971) and in U.S. Patent 4,703,004. A preferred screening technique is the antibody capture technique described in Beckmann et al., (*J. Immunol.* 144:4212, 1990). Positive hybridoma cells can be injected intraperitoneally into syngeneic BALB/c mice to produce ascites containing high concentrations of anti-HPR1 or anti-HPR2 monoclonal antibodies. Alternatively, hybridoma cells can be grown *in vitro* in flasks or roller bottles by various techniques. Monoclonal antibodies produced in mouse ascites can be purified by ammonium sulfate precipitation, followed by gel exclusion chromatography. Alternatively, affinity chromatography based upon binding of antibody to Polypeptide A or Polypeptide G can also be used, as can affinity chromatography based upon binding to HPR1 or HPR2 polypeptide.

**EXAMPLE 3****Antisense Inhibition of HPR1 and/or HPR2 Expression**

In accordance with the present invention, a series of oligonucleotides are designed to target different regions of HPR1 and/or HPR2 human or murine mRNA molecules, using the nucleotide sequences of SEQ ID NOs 3, 5, 19, 20, 22, 24, 28, and 29 as the bases for the design of the oligonucleotides. The oligonucleotides are selected to be approximately 10, 12, 15, 18, or more

5 preferably 20 nucleotide residues in length, and to have a predicted hybridization temperature that is at least 37 degrees C. Preferably, the oligonucleotides are selected so that some will hybridize toward the 5' region of the mRNA molecule, others will hybridize to the coding region, and still others will hybridize to the 3' region of the mRNA molecule.

10 The oligonucleotides may be oligodeoxynucleotides, with phosphorothioate backbones (internucleoside linkages) throughout, or may have a variety of different types of internucleoside linkages. Generally, methods for the preparation, purification, and use of a variety of chemically modified oligonucleotides are described in U.S. Patent No. 5,948,680. Modified oligonucleosides may also be used in oligonucleotide synthesis, as well as mixed backbone compounds having, for instance, alternating MMI and P=O or P=S linkages, which are prepared as described in U.S. Pat. Nos. 15 5,378,825, 5,386,023, 5,489,677, 5,602,240 and 5,610,289. Formacetal- and thioformacetal-linked oligonucleosides may also be used and are prepared as described in U.S. Pat. Nos. 5,264,562 and 5,264,564; and ethylene oxide linked oligonucleosides may also be used and are prepared as described in U.S. Pat. No. 5,223,618. Peptide nucleic acids (PNAs) may be used as in the same manner as the oligonucleotides described above, and are prepared in accordance with any of the various procedures 20 referred to in Peptide Nucleic Acids (PNA): Synthesis, Properties and Potential Applications, Bioorganic & Medicinal Chemistry, 1996, 4, 5-23; and U.S. Pat. Nos. 5,539,082, 5,700,922, and 5,719,262. Chimeric oligonucleotides, oligonucleosides, or mixed oligonucleotides/oligonucleosides of the invention are synthesized according to U.S. Pat. No. 5,623,065.

25 The effect of antisense compounds on target nucleic acid expression can be tested in any of a variety of cell types provided that the target nucleic acid is present at measurable levels. This can be routinely determined using, for example, PCR or Northern blot analysis. Preferably, the effect of several different oligonucleotides should be tested simultaneously, where the oligonucleotides hybridize to different portions of the target nucleic acid molecules, in order to identify the oligonucleotides producing the greatest degree of inhibition of expression of the target nucleic acid. 30 Antisense modulation of HPR1 and/or HPR2 nucleic acid expression can be assayed in a variety of ways known in the art. For example, HPR1 and HPR2 mRNA levels can be quantitated by, e.g., Northern blot analysis, competitive polymerase chain reaction (PCR), or real-time PCR (RT-PCR). Real-time quantitative PCR is presently preferred. RNA analysis can be performed on total cellular RNA or poly(A)+ mRNA. Methods of RNA isolation and Northern blot analysis are taught in, for 35 example, Ausubel, F. M. et al., Current Protocols in Molecular Biology, Volume 1, pp. 4.1.1-4.2.9 and 4.5.1-4.5.3, John Wiley & Sons, Inc., 1996. Real-time quantitative (PCR) can be conveniently accomplished using the commercially available ABI PRISM 7700 Sequence Detection System, available from PE-Applied Biosystems, Foster City, Calif. and used according to manufacturer's instructions. Other methods of quantitative PCR analysis are also known in the art. HPR1 and HPR2 40 protein levels can be quantitated in a variety of ways well known in the art, such as immunoprecipitation, Western blot analysis (immunoblotting), ELISA, or fluorescence-activated cell sorting (FACS). Antibodies directed to HPR1 and/or HPR2 polypeptides can be prepared via

5 conventional antibody generation methods such as those described herein. Immunoprecipitation methods, Western blot (immunoblot) analysis, and enzyme-linked immunosorbent assays (ELISA) are standard in the art (see, for example, Ausubel, F. M. et al., Current Protocols in Molecular Biology, Volume 2, pp. 10.16.1-10.16.11, 10.8.1-10.8.21, and 11.2.1-11.2.22, John Wiley & Sons, Inc., 1991).

10 All publications and patent applications cited in this specification are herein incorporated by reference as if each individual publication or patent application were specifically and individually indicated to be incorporated by reference. Although the foregoing invention has been described in some detail by way of illustration and example for purposes of clarity of understanding, it will be readily apparent to those of ordinary skill in the art in light of the teachings of this invention that certain changes and modifications may be made thereto without departing from the spirit or scope of  
15 the appended claims.

#### Sequences Presented in the Sequence Listing

SEQ ID NO	Type	Description
SEQ ID NO:1	Amino acid	Partial human HPR1 amino acid sequence
SEQ ID NO:2	Amino acid	Partial human HPR1 amino acid sequence
SEQ ID NO:3	Nucleotide	Human HPR1 cDNA sequence
SEQ ID NO:4	Amino acid	Human HPR1 amino acid sequence (745 amino acids)
SEQ ID NO:5	Nucleotide	Human HPR1 coding sequence
SEQ ID NO:6	Amino acid	Human LIF-R amino acid sequence (GenBank NP_002301)
SEQ ID NO:7	Amino acid	Human IL-12RB2 amino acid sequence (GenBank NP_001550)
SEQ ID NO:8	Amino acid	Human gp130 amino acid sequence (GenBank NP_002175)
SEQ ID NO:9	Amino acid	Human GCSFR amino acid sequence (SWISS-PROT Q99062)
SEQ ID NO:10	Amino acid	Portion of possible alternatively spliced form of human HPR1
SEQ ID NO:11	Amino acid	Portion of possible alternatively spliced form of human HPR1
SEQ ID NO:12	Amino acid	Mus musculus HPR1 amino acid sequence
SEQ ID NO:13	Amino acid	Possible 252-aa human HPR1 variant (WO 00/75314)
SEQ ID NO:14	Amino acid	Possible 652-aa human HPR1 variant (WO 00/75314)
SEQ ID NO:15	Amino acid	Possible 662-aa human HPR1 variant (WO 00/75314)
SEQ ID NO:16	Amino acid	Portion of possible alternatively spliced form of human HPR2
SEQ ID NO:17	Amino acid	Portion of possible alternatively spliced form of human HPR2
SEQ ID NO:18	Amino acid	Portion of possible alternatively spliced form of human HPR2
SEQ ID NO:19	Nucleotide	Human HPR2 cDNA sequence - exons 1 through 11
SEQ ID NO:20	Nucleotide	Human HPR2 coding sequence (encodes 629-aa form)
SEQ ID NO:21	Amino acid	Human HPR2 amino acid sequence (629 amino acids)
SEQ ID NO:22	Nucleotide	Human HPR2-ex8-ex9 coding sequence (encodes 565-aa form)
SEQ ID NO:23	Amino acid	Human HPR2-ex8-ex9 amino acid sequence (565 amino acids)
SEQ ID NO:24	Nucleotide	Human HPR2-ex9 coding sequence (encodes 356-aa form)
SEQ ID NO:25	Amino acid	Human HPR2-ex9 amino acid sequence (356 amino acids)
SEQ ID NO:26	Amino acid	Possible 384-aa human HPR2 variant (WO 00/73451)
SEQ ID NO:27	Amino acid	Mus musculus HPR2 amino acid sequence
SEQ ID NO:28	Nucleotide	Mus musculus HPR1 coding sequence
SEQ ID NO:29	Nucleotide	Mus musculus HPR2 coding sequence

5

CLAIMS

What is claimed is:

1. An isolated polypeptide having HPR1 polypeptide activity comprising an amino acid sequence selected from the group consisting of:
  - (a) the amino acid sequence of SEQ ID NO:4;
  - 10 (b) an amino acid sequence selected from the group consisting of: amino acids 652 through 745 of SEQ ID NO:4, a fragment of the sequence of amino acids 652 through 745 of SEQ ID NO:4 comprising at least 20 contiguous amino acids; a fragment of the sequence of amino acids 652 through 745 of SEQ ID NO:4 comprising at least 30 contiguous amino acids; a fragment of the sequence of amino acids 652 through 745 of SEQ ID NO:4 that is at least 25% of the length of the sequence of amino acids 652 through 745 of SEQ ID NO:4; a fragment of the sequence of amino acids 652 through 745 of SEQ ID NO:4 that is at least 50% of the length of the sequence of amino acids 652 through 745 of SEQ ID NO:4; and a fragment of the sequence of amino acids 652 through 745 of SEQ ID NO:4 comprising at least eight contiguous amino acids and comprising at least one tyrosine residue;
  - 20 (c) an amino acid sequence comprising at least 8 amino acids and sharing amino acid identity with the amino acid sequences of (b), wherein the percent amino acid identity is selected from the group consisting of: at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, at least 97.5%, at least 99%, and at least 99.5%;
  - 25 (d) an amino acid sequence comprising both an amino acid sequence of (b) or (c), and an amino acid sequence selected from the group consisting of: amino acids 1 through 55 of SEQ ID NO:1; amino acids 56 through 77 of SEQ ID NO:1; amino acids 5 through 40 of SEQ ID NO:2; amino acids 1 through 32 of SEQ ID NO:4; amino acids 1 through 241 of SEQ ID NO:4; amino acids 1 through 525 of SEQ ID NO:4; amino acids 20 through 32 of SEQ ID NO:4; amino acids 33 through 134 of SEQ ID NO:4; amino acids Xaa1 through Xaa2 of SEQ ID NO:4, wherein Xaa1 is selected from the group consisting of amino acids 33 through 43 of SEQ ID NO:4 and Xaa2 is selected from the group consisting of amino acids 228 through 241 of SEQ ID NO:4; amino acids 33 through 238 of SEQ ID NO:4; amino acids 33 through 241 of SEQ ID NO:4; amino acids 33 through 525 of SEQ ID NO:4; amino acids 33 through 745 of SEQ ID NO:4; amino acids 44 through 94 of SEQ ID NO:4; amino acids 139 through 241 of SEQ ID NO:4; amino acids 242 through 326 of SEQ ID NO:4; amino acids 242 through 514 of SEQ ID NO:4; amino acids 337 through 419 of SEQ ID NO:4; amino acids 433 through 514 of SEQ ID NO:4; amino acids 526 through 556 of SEQ ID NO:4; amino acids 533 through 552 of SEQ ID NO:4; amino acids 553 through 745 of SEQ ID NO:4; amino acids 557 through 745 of SEQ ID NO:4; amino acids 563 through 573 of SEQ ID NO:4; amino acids 563 through 641 of SEQ ID NO:4; amino acids 567 through 581 of SEQ ID NO:4; amino acids 588 through 639 of SEQ ID NO:4; amino acids 631 through 641 of SEQ ID NO:4; SEQ ID NO:10; and SEQ ID NO:11;
  - 30
  - 35
  - 40

- 5 (e) an amino acid sequence comprising both an amino acid sequence of (b) or (c), and a fragment of SEQ ID NO:4 comprising cytokine receptor domain amino acid sequences;
- (f) an allelic variant of any of (a)-(e); and
- (g) an amino acid sequence of (a)-(f), wherein a polypeptide comprising said amino acid sequence of (a)-(f) binds to an antibody that also binds to a polypeptide comprising an amino acid sequence of any of (b)-(c).
- 10

2. An isolated polypeptide having HPR1 polypeptide activity comprising an amino acid sequence selected from the group consisting of:

- (a) the amino acid sequence of SEQ ID NO:12;
- 15 (b) an amino acid sequence selected from the group consisting of: amino acids 633 through 726 of SEQ ID NO:12, a fragment of the sequence of amino acids 633 through 726 of SEQ ID NO:12 comprising at least 20 contiguous amino acids; a fragment of the sequence of amino acids 633 through 726 of SEQ ID NO:12 comprising at least 30 contiguous amino acids; a fragment of the sequence of amino acids 633 through 726 of SEQ ID NO:12 that is at least 25% of the length of the sequence of amino acids 633 through 726 of SEQ ID NO:12; a fragment of the sequence of amino acids 633 through 726 of SEQ ID NO:12 that is at least 50% of the length of the sequence of amino acids 633 through 726 of SEQ ID NO:12; and a fragment of the sequence of amino acids 633 through 726 of SEQ ID NO:12 comprising at least eight contiguous amino acids and comprising at least one tyrosine residue;
- 20 (c) an amino acid sequence comprising at least 8 amino acids and sharing amino acid identity with the amino acid sequences of (b), wherein the percent amino acid identity is selected from the group consisting of: at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, at least 97.5%, at least 99%, and at least 99.5%;
- 25 (d) an amino acid sequence comprising both an amino acid sequence of (b) or (c), and an amino acid sequence selected from the group consisting of: amino acids 1 through 28 of SEQ ID NO:12; amino acids 1 through 224 of SEQ ID NO:12; amino acids 1 through 509 of SEQ ID NO:12; amino acids 13 through 28 of SEQ ID NO:12; amino acids 29 through 124 of SEQ ID NO:12; amino acids Xaa1 through Xaa2 of SEQ ID NO:12, wherein Xaa1 is selected from the group consisting of amino acids 29 through 39 of SEQ ID NO:12 and Xaa2 is selected from the group consisting of amino acids 211 through 224 of SEQ ID NO:12; amino acids 29 through 128 of SEQ ID NO:12; amino acids 29 through 224 of SEQ ID NO:12; amino acids 29 through 509 of SEQ ID NO:12; amino acids 29 through 726 of SEQ ID NO:12; amino acids 129 through 224 of SEQ ID NO:12; amino acids 225 through 309 of SEQ ID NO:12; amino acids 225 through 499 of SEQ ID NO:12; amino acids 320 through 403 of SEQ ID NO:12; amino acids 417 through 508 of SEQ ID NO:12; amino acids 510 through 533 of SEQ ID NO:12; amino acids 517 through 532 of SEQ ID NO:12; amino acids 534 through 726 of SEQ ID NO:12; amino acids 547 through 557 of
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- 35
- 40

- 5 SEQ ID NO:12; amino acids 547 through 622 of SEQ ID NO:12; and amino acids 612 through 622 of SEQ ID NO:12;
- (e) an amino acid sequence comprising both an amino acid sequence of (b) or (c), and a fragment of SEQ ID NO:12 comprising cytokine receptor domain amino acid sequences;
- (f) an allelic variant of any of (a)-(e); and
- 10 (g) an amino acid sequence of (a)-(f), wherein a polypeptide comprising said amino acid sequence of (a)-(f) binds to an antibody that also binds to a polypeptide comprising an amino acid sequence of any of (b)-(c).
3. An isolated polypeptide having HPR2 polypeptide activity comprising an amino acid
- 15 sequence selected from the group consisting of:
- (a) SEQ ID NO:23;
- (b) SEQ ID NO:25;
- (c) an amino acid sequence selected from the group consisting of: an amino acid sequence comprising at least 20 contiguous amino acids of SEQ ID NO:23 and comprising the
- 20 contiguous amino acids 318 and 319 of SEQ ID NO:23; and amino acids 349 through 356 of SEQ ID NO:25;
- (d) an amino acid sequence comprising at least 8 amino acids and sharing amino acid identity with the amino acid sequences of (c), wherein the percent amino acid identity is selected from the group consisting of: at least 70%, at least 75%, at least 80%, at least 85%, at least 90%,
- 25 at least 95%, at least 97.5%, at least 99%, and at least 99.5%;
- (e) an amino acid sequence comprising both an amino acid sequence of (c) or (d), and an amino acid sequence selected from the group consisting of: amino acids 1 through 177 of SEQ ID NO:16; amino acids 216 through 245 of SEQ ID NO:16; SEQ ID NO:17; and SEQ ID NO:18;
- (f) an amino acid sequence comprising both an amino acid sequence of (c) or (d), and an
- 30 amino acid sequences of any of (a)-(b) comprising cytokine receptor domain amino acid sequences;
- (g) an allelic variant of any of (a)-(f); and
- (h) an amino acid sequence of (a)-(g), wherein a polypeptide comprising said amino acid sequence of (a)-(g) binds to an antibody that also binds to a polypeptide comprising an amino acid
- 35 sequence of any of (c)-(d).
4. An isolated polypeptide having HPR2 polypeptide activity comprising an amino acid sequence selected from the group consisting of:
- (a) SEQ ID NO:27;
- 40 (b) SEQ ID NO:27 from which amino acids 297 through 316 or amino acids 317 through 336 have been deleted;

- 5 (c) an amino acid sequence comprising 20 or more contiguous amino acids of (a) or (b);  
and  
(d) an amino acid sequence comprising 30 or more contiguous amino and sharing at least  
90% amino acid identity with the amino acid sequences of (a)-(b).
- 10 5. An isolated nucleic acid encoding a polypeptide of any of claims 1 through 4.
6. The nucleic acid of claim 5 comprising a nucleotide sequence selected from the group  
consisting of:
- 15 (a) SEQ ID NO:3;  
(b) SEQ ID NO:5;  
(c) nucleotides 132 through 2366 of SEQ ID NO:3; and  
(d) allelic variants of (a)-(c).
7. The nucleic acid of claim 5 comprising a nucleotide sequence selected from the group  
20 consisting of nucleotides 1 through 137 of SEQ ID NO:3, nucleotides 138 through 228 of SEQ ID  
NO:3, nucleotides 229 through 346 of SEQ ID NO:3, nucleotides 347 through 528 of SEQ ID NO:3,  
nucleotides 529 through 680 of SEQ ID NO:3, nucleotides 681 through 846 of SEQ ID NO:3,  
nucleotides 847 through 926 of SEQ ID NO:3, nucleotides 927 through 1143 of SEQ ID NO:3,  
nucleotides 1144 through 1326 of SEQ ID NO:3, nucleotides 1327 through 1428 of SEQ ID NO:3,  
25 nucleotides 1429 through 1575 of SEQ ID NO:3, nucleotides 1576 through 1716 of SEQ ID NO:3,  
nucleotides 1717 through 1810 of SEQ ID NO:3, nucleotides 1811 through 1892 of SEQ ID NO:3, and  
nucleotides 1893 through 2480 of SEQ ID NO:3.
8. The nucleic acid of claim 5 comprising a nucleotide sequence selected from the group  
30 consisting of:
- (a) SEQ ID NO:28; and  
(b) allelic variants of (a).
9. The nucleic acid of claim 5 comprising a nucleotide sequence selected from the group  
35 consisting of:
- (a) SEQ ID NO:19;  
(b) SEQ ID NO:20;  
(c) SEQ ID NO:22;  
(d) SEQ ID NO:24; and  
40 (d) allelic variants of (a)-(d).

- 5      10.      The nucleic acid of claim 5 comprising a nucleotide sequence selected from the group  
consisting of: nucleotides 107 through 175 of SEQ ID NO:19, nucleotides 107 through 478 of SEQ ID  
NO:19, nucleotides 107 through 1060 of SEQ ID NO:19, nucleotides 107 through 1099 of SEQ ID  
NO:19, nucleotides 107 through 1171 of SEQ ID NO:19, nucleotides 176 through 478 of SEQ ID  
NO:19, nucleotides 176 through 1099 of SEQ ID NO:19, nucleotides 176 through 1171 of SEQ ID  
10      NO:19, nucleotides 479 through 763 of SEQ ID NO:19, nucleotides 479 through 1099 of SEQ ID  
NO:19, nucleotides 503 through 1033 of SEQ ID NO:19, nucleotides 776 through 1066 of SEQ ID  
NO:19, nucleotides 776 through 1099 of SEQ ID NO:19, nucleotides 1061 through 1801 of SEQ ID  
NO:19, nucleotides 1232 through 1993 of SEQ ID NO:19, nucleotides 1283 through 1426 of SEQ ID  
NO:19, nucleotides 1283 through 1960 of SEQ ID NO:19, and nucleotides 1295 through 1939 of SEQ  
15      ID NO:19.
11.      The nucleic acid of claim 5 comprising the nucleotide sequence of SEQ ID NO:29.
12.      An isolated genomic nucleic acid corresponding to the nucleic acid of any of claims 5 to 11.
- 20      13.      An expression vector comprising at least one nucleic acid according to any of claims 5 though  
12.
14.      A recombinant host cell comprising at least one nucleic acid according to any of claims 5  
25      though 12.
15.      The recombinant host cell of claim 14, wherein the nucleic acid is integrated into the host cell  
genome.
- 30      16.      A process for producing a polypeptide encoded by the nucleic acid of any of claims 5 though  
12, comprising culturing a recombinant host cell under conditions promoting expression of said  
polypeptide, wherein the recombinant host cell comprises at least one nucleic acid according to any of  
claims 5 though 12.
- 35      17.      The process of claim 16 further comprising purifying said polypeptide.
18.      The polypeptide produced by the process of claim 17.
19.      An isolated antibody that binds to the polypeptide of any of claims 1 through 4 or claim 18.
- 40      20.      The antibody of claim 19 wherein the antibody is a monoclonal antibody.



- 5      21.      The antibody of claim 19 wherein the antibody is a human antibody.
22.      The antibody of claim 19 wherein the antibody is a humanized antibody.
23.      The antibody of claim 19 wherein the antibody inhibits the activity of the polypeptide of any  
10      of claims 1 through 4 or claim 18.
24.      A method of designing an inhibitor of the polypeptide of any of claims 1 through 4 or claim  
18, the method comprising the steps of determining the three-dimensional structure of such  
15      polypeptide, analyzing the three-dimensional structure for the likely binding sites of substrates,  
synthesizing a molecule that incorporates a predicted reactive site, and determining the polypeptide-  
inhibiting activity of the molecule.
25.      A method for identifying compounds that alter HPR1 or HRP2 polypeptide activity  
comprising
- 20      (a)      mixing a test compound with the polypeptide of any of claims 1 through 4 or claim  
18; and
- (b)      determining whether the test compound alters the HPR1 or HRP2 polypeptide  
activity of said polypeptide.
- 25      26.      A method for identifying compounds that inhibit the binding activity of HPR1 or HRP2  
polypeptides comprising (a) mixing a test compound with the polypeptide of any of claims 1 through 4  
or claim 18 and a binding partner of said polypeptide; and (b) determining whether the test compound  
inhibits the binding activity of said polypeptide.
- 30      27.      A method for increasing ligand-binding activity comprising providing at least one compound  
selected from the group consisting of the polypeptide of any of claims 1 through 4 or claim 18 and  
agonists of said polypeptides.
28.      The method of claim 27 wherein the method comprises increasing ligand-binding activity in a  
35      patient by administering to said patient at least one compound selected from the group consisting of the  
polypeptide of any of claims 1 through 4 or claim 18 and agonists of said polypeptides.
29.      A method for decreasing ligand-binding activity comprising providing at least one antagonist  
of the polypeptide of any of claims 1 through 4 or claim 18.

40

- 5      30.      The method of claim 29 wherein the method comprises decreasing ligand-binding activity in a patient by administering at least one antagonist of the polypeptide of any of claims 1 through 4 or claim 18 to said patient.
- 10      31.      The method of claim 29 wherein the antagonist is an antibody that inhibits the activity of said polypeptide.
- 15      32.      A method for treating a cell proliferation condition comprising administering at least one compound selected from the group consisting of the polypeptide of any of claims 1 through 4 or claim 18 and agonists of said polypeptides.
- 20      33.      The method of claim 32 wherein the cell proliferation condition is selected from the group consisting of pancytopenia, leukopenia, anemia, thrombocytopenia, neurodegenerative disorders, and osteoporosis resulting from a lack of bone-forming cells.
- 25      34.      A method for treating a cell proliferation condition comprising administering an antagonist of the polypeptide of any of claims 1 through 4 or claim 18.
35.      The method of claim 34 wherein the cell proliferation condition is selected from the group consisting of leukemia, tumour metastasis, and osteoporosis resulting from an excess of bone-resorbing cells.

## SEQUENCE LISTING

<110> Immunex Corporation  
 Cosman, David J.  
 Mosley, Bruce A.  
 Bird, Timothy A.  
 DuBose, Robert F.  
 Wiley, Steven R.

<120> HEMATOPOIETIN RECEPTORS HPR1 AND HPR2

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 gtggaaaagg atttccaag acagtcaatt ccagcatctt gcagtacggc ctggagtccc 1620

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ccccaaatcc atatttgaaa aattcagtga cagccagga atttcttgtg tctgaaaaac 2340
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cctgccacat cctgcctagg 2480

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&lt;210&gt; 4

&lt;211&gt; 745

&lt;212&gt; PRT

&lt;213&gt; Homo sapiens

&lt;400&gt; 4

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Met Lys Leu Ser Pro Gln Pro Ser Cys Val Asn Leu Gly Met Met Trp
1          5          10          15

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Thr Trp Ala Leu Trp Met Leu Pro Ser Leu Cys Lys Phe Ser Leu Ala
          20          25          30

```

```

Ala Leu Pro Ala Lys Pro Glu Asn Ile Ser Cys Val Tyr Tyr Tyr Arg
          35          40          45

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```

Lys Asn Leu Thr Cys Thr Trp Ser Pro Gly Lys Glu Thr Ser Tyr Thr
          50          55          60

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Gln Tyr Thr Val Lys Arg Thr Tyr Ala Phe Gly Glu Lys His Asp Asn
65          70          75          80

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```

Cys Thr Thr Asn Ser Ser Thr Ser Glu Asn Arg Ala Ser Cys Ser Phe
          85          90          95

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Phe Leu Pro Arg Ile Thr Ile Pro Asp Asn Tyr Thr Ile Glu Val Glu  
 100 105 110

Ala Glu Asn Gly Asp Gly Val Ile Lys Ser His Met Thr Tyr Trp Arg  
 115 120 125

Leu Glu Asn Ile Ala Lys Thr Glu Pro Pro Lys Ile Phe Arg Val Lys  
 130 135 140

Pro Val Leu Gly Ile Lys Arg Met Ile Gln Ile Glu Trp Ile Lys Pro  
 145 150 155 160

Glu Leu Ala Pro Val Ser Ser Asp Leu Lys Tyr Thr Leu Arg Phe Arg  
 165 170 175

Thr Val Asn Ser Thr Ser Trp Met Glu Val Asn Phe Ala Lys Asn Arg  
 180 185 190

Lys Asp Lys Asn Gln Thr Tyr Asn Leu Thr Gly Leu Gln Pro Phe Thr  
 195 200 205

Glu Tyr Val Ile Ala Leu Arg Cys Ala Val Lys Glu Ser Lys Phe Trp  
 210 215 220

Ser Asp Trp Ser Gln Glu Lys Met Gly Met Thr Glu Glu Glu Ala Pro  
 225 230 235 240

Cys Gly Leu Glu Leu Trp Arg Val Leu Lys Pro Ala Glu Ala Asp Gly  
 245 250 255

Arg Arg Pro Val Arg Leu Leu Trp Lys Lys Ala Arg Gly Ala Pro Val  
 260 265 270

Leu Glu Lys Thr Leu Gly Tyr Asn Ile Trp Tyr Tyr Pro Glu Ser Asn  
 275 280 285

Thr Asn Leu Thr Glu Thr Met Asn Thr Thr Asn Gln Gln Leu Glu Leu  
 290 295 300

His Leu Gly Gly Glu Ser Phe Trp Val Ser Met Ile Ser Tyr Asn Ser  
 305 310 315 320

Leu Gly Lys Ser Pro Val Ala Thr Leu Arg Ile Pro Ala Ile Gln Glu  
 325 330 335

Lys Ser Phe Gln Cys Ile Glu Val Met Gln Ala Cys Val Ala Glu Asp  
 340 345 350

Gln Leu Val Val Lys Trp Gln Ser Pro Ala Leu Asp Val Asn Thr Trp  
 355 360 365

Met Ile Glu Trp Phe Pro Asp Val Asp Ser Glu Pro Thr Thr Leu Ser  
 370 375 380

Trp Glu Ser Val Ser Gln Ala Thr Asn Trp Thr Ile Gln Gln Asp Lys  
 385 390 395 400

Leu Lys Pro Phe Trp Cys Tyr Asn Ile Ser Val Tyr Pro Met Leu His  
 405 410 415

Asp Lys Val Gly Glu Pro Tyr Ser Ile Gln Ala Tyr Ala Lys Glu Gly  
 420 425 430

Val Pro Ser Glu Gly Pro Glu Thr Lys Val Glu Asn Ile Gly Val Lys  
 435 440 445

Thr Val Thr Ile Thr Trp Lys Glu Ile Pro Lys Ser Glu Arg Lys Gly  
 450 455 460

Ile Ile Cys Asn Tyr Thr Ile Phe Tyr Gln Ala Glu Gly Gly Lys Gly  
 465 470 475 480

Phe Ser Lys Thr Val Asn Ser Ser Ile Leu Gln Tyr Gly Leu Glu Ser  
 485 490 495

Leu Lys Arg Lys Thr Ser Tyr Ile Val Gln Val Met Ala Ser Thr Ser  
 500 505 510

Ala Gly Gly Thr Asn Gly Thr Ser Ile Asn Phe Lys Thr Leu Ser Phe  
 515 520 525

Ser Val Phe Glu Ile Ile Leu Ile Thr Ser Leu Ile Gly Gly Gly Leu  
 530 535 540

Leu Ile Leu Ile Ile Leu Thr Val Ala Tyr Gly Leu Lys Lys Pro Asn  
 545 550 555 560

Lys Leu Thr His Leu Cys Trp Pro Thr Val Pro Asn Pro Ala Glu Ser  
 565 570 575

Ser Ile Ala Thr Trp His Gly Asp Asp Phe Lys Asp Lys Leu Asn Leu  
580 585 590

Lys Glu Ser Asp Asp Ser Val Asn Thr Glu Asp Arg Ile Leu Lys Pro  
595 600 605

Cys Ser Thr Pro Ser Asp Lys Leu Val Ile Asp Lys Leu Val Val Asn  
610 615 620

Phe Gly Asn Val Leu Gln Glu Ile Phe Thr Asp Glu Ala Arg Thr Gly  
625 630 635 640

Gln Glu Asn Asn Leu Gly Gly Glu Lys Asn Gly Tyr Val Thr Cys Pro  
645 650 655

Phe Arg Pro Asp Cys Pro Leu Gly Lys Ser Phe Glu Glu Leu Pro Val  
660 665 670

Ser Pro Glu Ile Pro Pro Gly Lys Ser Gln Tyr Leu Arg Ser Arg Met  
675 680 685

Pro Glu Gly Thr Arg Pro Glu Ala Lys Glu Gln Leu Leu Phe Ser Gly  
690 695 700

Gln Ser Leu Val Pro Asp His Leu Cys Glu Glu Gly Ala Pro Asn Pro  
705 710 715 720

Tyr Leu Lys Asn Ser Val Thr Ala Arg Glu Phe Leu Val Ser Glu Lys  
725 730 735

Leu Pro Glu His Thr Lys Gly Glu Val  
740 745

<210> 5  
<211> 2238  
<212> DNA  
<213> Homo sapiens

<400> 5  
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tgatgtctcc cttcactctg caaatccagc ctggcagctc tgccagctaa gcctgagaac 120  
atttcctgtg tctactacta taggaaaaat ttaacctgca cttggagtcc aggaaaggaa 180  
accagttata ccagtacac agttaagaga acttacgctt ttggagaaaa acatgataat 240  
tgtacaacca atagttctac aagtgaatat cgtgcttcgt gctctttttt ccttccaaga 300  
ataacgatcc cagataatta taccattgag gtggaagctg aaaatggaga tgggtgtaatt 360



aaatctcata	tgacatactg	gagattagag	aacatagcga	aaactgaacc	acctaagatt	420
ttccgtgtga	aaccagtttt	gggcatcaaa	cgaatgattc	aaattgaatg	gataaagcct	480
gagttggcgc	ctgtttcatc	tgatttaaaa	tacacacttc	gattcaggac	agtcaacagt	540
accagctgga	tggaagtcaa	cttcgctaag	aaccgtaagg	ataaaaacca	aacgtacaac	600
ctcacggggc	tgcagccttt	tacagaatat	gtcatagctc	tgcgatgtgc	ggtcaaggag	660
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tgtggcctgg	aactgtggag	agtcctgaaa	ccagctgagg	cggatggaag	aaggccagtg	780
cggttgttat	ggaagaaggc	aagaggagcc	ccagtcctag	agaaaacact	tggctacaac	840
atatggtact	atccagaaa	caacactaac	ctcacagaaa	caatgaacac	tactaaccag	900
cagcttgaac	tgcattctggg	aggcgagagc	ttttgggtgt	ctatgatttc	ttataattct	960
cttgggaagt	ctccagtggc	caccctgagg	attccagcta	ttcaagaaaa	atcatttcag	1020
tgcattgagg	tcatgcaggc	ctgcgttgct	gaggaccagc	tagtggtgaa	gtggcaaagc	1080
cctgctctag	acgtgaacac	ttggatgatt	gaatggtttc	cggatgtgga	ctcagagccc	1140
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ttaaaacctt	tctggtgcta	taacatctct	gtgtatccaa	tgttgcattga	caaagttggc	1260
gagccatatt	ccatccaggc	ttatgccaaa	gaaggcgttc	catcagaagg	tcctgagacc	1320
aaggtggaga	acattggcgt	gaagacggtc	acgatcacat	ggaaagagat	tccaagagt	1380
gagagaaagg	gtatcatctg	caactacacc	atcttttacc	aagctgaagg	tggaaaagga	1440
ttctccaaga	cagtcaattc	cagcatcttg	cagtacggcc	tggagtccct	gaaacgaaag	1500
acctcttaca	ttgttcaggt	catggccagc	accagtgtctg	ggggaaccga	cgggaccagc	1560
ataaatttca	agacattgtc	attcagtgtc	tttgagatta	tcctcataac	ttctctgatt	1620
ggtggaggcc	ttcttattct	cattatctctg	acagtggcat	atggtctcaa	aaaacccaac	1680
aaattgactc	atctgtgttg	gccaccggt	cccaaccctg	ctgaaagtag	tatagccaca	1740
tggcatggag	atgatttcaa	ggataagcta	aacctgaagg	agtctgatga	ctctgtgaac	1800
acagaagaca	ggatcttaaa	accatgttcc	acccccagtg	acaagttggt	gattgacaag	1860
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caggaaaaca	atttaggagg	ggaaaagaat	gggtatgtga	cctgcccctt	caggcctgat	1980
tgtcccctgg	ggaaaagttt	tgaggagctc	ccagtttcac	ctgagattcc	gcccggaaaa	2040
tccaataacc	tacgttcgag	gatgccagag	gggaccgcgc	cagaagccaa	agagcagctt	2100
ctcttttctg	gtcaaagttt	agtaccagat	catctgtgtg	aggaaggagc	cccaaattcca	2160

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accaagggag aagtctaa 2238

<210> 6

<211> 1097

<212> PRT

<213> Homo sapiens

<400> 6

Met Met Asp Ile Tyr Val Cys Leu Lys Arg Pro Ser Trp Met Val Asp  
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Asn Lys Arg Met Arg Thr Ala Ser Asn Phe Gln Trp Leu Leu Ser Thr  
20 25 30

Phe Ile Leu Leu Tyr Leu Met Asn Gln Val Asn Ser Gln Lys Lys Gly  
35 40 45

Ala Pro His Asp Leu Lys Cys Val Thr Asn Asn Leu Gln Val Trp Asn  
50 55 60

Cys Ser Trp Lys Ala Pro Ser Gly Thr Gly Arg Gly Thr Asp Tyr Glu  
65 70 75 80

Val Cys Ile Glu Asn Arg Ser Arg Ser Cys Tyr Gln Leu Glu Lys Thr  
85 90 95

Ser Ile Lys Ile Pro Ala Leu Ser His Gly Asp Tyr Glu Ile Thr Ile  
100 105 110

Asn Ser Leu His Asp Phe Gly Ser Ser Thr Ser Lys Phe Thr Leu Asn  
115 120 125

Glu Gln Asn Val Ser Leu Ile Pro Asp Thr Pro Glu Ile Leu Asn Leu  
130 135 140

Ser Ala Asp Phe Ser Thr Ser Thr Leu Tyr Leu Lys Trp Asn Asp Arg  
145 150 155 160

Gly Ser Val Phe Pro His Arg Ser Asn Val Ile Trp Glu Ile Lys Val  
165 170 175

Leu Arg Lys Glu Ser Met Glu Leu Val Lys Leu Val Thr His Asn Thr  
180 185 190

Thr Leu Asn Gly Lys Asp Thr Leu His His Trp Ser Trp Ala Ser Asp

195					200					205					
Met	Pro	Leu	Glu	Cys	Ala	Ile	His	Phe	Val	Glu	Ile	Arg	Cys	Tyr	Ile
210						215					220				
Asp	Asn	Leu	His	Phe	Ser	Gly	Leu	Glu	Glu	Trp	Ser	Asp	Trp	Ser	Pro
225					230					235					240
Val	Lys	Asn	Ile	Ser	Trp	Ile	Pro	Asp	Ser	Gln	Thr	Lys	Val	Phe	Pro
				245					250					255	
Gln	Asp	Lys	Val	Ile	Leu	Val	Gly	Ser	Asp	Ile	Thr	Phe	Cys	Cys	Val
			260					265					270		
Ser	Gln	Glu	Lys	Val	Leu	Ser	Ala	Leu	Ile	Gly	His	Thr	Asn	Cys	Pro
		275					280					285			
Leu	Ile	His	Leu	Asp	Gly	Glu	Asn	Val	Ala	Ile	Lys	Ile	Arg	Asn	Ile
	290					295					300				
Ser	Val	Ser	Ala	Ser	Ser	Gly	Thr	Asn	Val	Val	Phe	Thr	Thr	Glu	Asp
305					310					315					320
Asn	Ile	Phe	Gly	Thr	Val	Ile	Phe	Ala	Gly	Tyr	Pro	Pro	Asp	Thr	Pro
				325					330					335	
Gln	Gln	Leu	Asn	Cys	Glu	Thr	His	Asp	Leu	Lys	Glu	Ile	Ile	Cys	Ser
			340					345					350		
Trp	Asn	Pro	Gly	Arg	Val	Thr	Ala	Leu	Val	Gly	Pro	Arg	Ala	Thr	Ser
		355					360					365			
Tyr	Thr	Leu	Val	Glu	Ser	Phe	Ser	Gly	Lys	Tyr	Val	Arg	Leu	Lys	Arg
	370					375					380				
Ala	Glu	Ala	Pro	Thr	Asn	Glu	Ser	Tyr	Gln	Leu	Leu	Phe	Gln	Met	Leu
385					390					395					400
Pro	Asn	Gln	Glu	Ile	Tyr	Asn	Phe	Thr	Leu	Asn	Ala	His	Asn	Pro	Leu
				405					410					415	
Gly	Arg	Ser	Gln	Ser	Thr	Ile	Leu	Val	Asn	Ile	Thr	Glu	Lys	Val	Tyr
			420					425					430		
Pro	His	Thr	Pro	Thr	Ser	Phe	Lys	Val	Lys	Asp	Ile	Asn	Ser	Thr	Ala
		435					440					445			

Val Lys Leu Ser Trp His Leu Pro Gly Asn Phe Ala Lys Ile Asn Phe  
 450 455 460

Leu Cys Glu Ile Glu Ile Lys Lys Ser Asn Ser Val Gln Glu Gln Arg  
 465 470 475 480

Asn Val Thr Ile Lys Gly Val Glu Asn Ser Ser Tyr Leu Val Ala Leu  
 485 490 495

Asp Lys Leu Asn Pro Tyr Thr Leu Tyr Thr Phe Arg Ile Arg Cys Ser  
 500 505 510

Thr Glu Thr Phe Trp Lys Trp Ser Lys Trp Ser Asn Lys Lys Gln His  
 515 520 525

Leu Thr Thr Glu Ala Ser Pro Ser Lys Gly Pro Asp Thr Trp Arg Glu  
 530 535 540

Trp Ser Ser Asp Gly Lys Asn Leu Ile Ile Tyr Trp Lys Pro Leu Pro  
 545 550 555 560

Ile Asn Glu Ala Asn Gly Lys Ile Leu Ser Tyr Asn Val Ser Cys Ser  
 565 570 575

Ser Asp Glu Glu Thr Gln Ser Leu Ser Glu Ile Pro Asp Pro Gln His  
 580 585 590

Lys Ala Glu Ile Arg Leu Asp Lys Asn Asp Tyr Ile Ile Ser Val Val  
 595 600 605

Ala Lys Asn Ser Val Gly Ser Ser Pro Pro Ser Lys Ile Ala Ser Met  
 610 615 620

Glu Ile Pro Asn Asp Asp Leu Lys Ile Glu Gln Val Val Gly Met Gly  
 625 630 635 640

Lys Gly Ile Leu Leu Thr Trp His Tyr Asp Pro Asn Met Thr Cys Asp  
 645 650 655

Tyr Val Ile Lys Trp Cys Asn Ser Ser Arg Ser Glu Pro Cys Leu Met  
 660 665 670

Asp Trp Arg Lys Val Pro Ser Asn Ser Thr Glu Thr Val Ile Glu Ser  
 675 680 685

Asp Glu Phe Arg Pro Gly Ile Arg Tyr Asn Phe Phe Leu Tyr Gly Cys  
 690 695 700

Arg Asn Gln Gly Tyr Gln Leu Leu Arg Ser Met Ile Gly Tyr Ile Glu  
 705 710 715 720

Glu Leu Ala Pro Ile Val Ala Pro Asn Phe Thr Val Glu Asp Thr Ser  
 725 730 735

Ala Asp Ser Ile Leu Val Lys Trp Glu Asp Ile Pro Val Glu Glu Leu  
 740 745 750

Arg Gly Phe Leu Arg Gly Tyr Leu Phe Tyr Phe Gly Lys Gly Glu Arg  
 755 760 765

Asp Thr Ser Lys Met Arg Val Leu Glu Ser Gly Arg Ser Asp Ile Lys  
 770 775 780

Val Lys Asn Ile Thr Asp Ile Ser Gln Lys Thr Leu Arg Ile Ala Asp  
 785 790 795 800

Leu Gln Gly Lys Thr Ser Tyr His Leu Val Leu Arg Ala Tyr Thr Asp  
 805 810 815

Gly Gly Val Gly Pro Glu Lys Ser Met Tyr Val Val Thr Lys Glu Asn  
 820 825 830

Ser Val Gly Leu Ile Ile Ala Ile Leu Ile Pro Val Ala Val Ala Val  
 835 840 845

Ile Val Gly Val Val Thr Ser Ile Leu Cys Tyr Arg Lys Arg Glu Trp  
 850 855 860

Ile Lys Glu Thr Phe Tyr Pro Asp Ile Pro Asn Pro Glu Asn Cys Lys  
 865 870 875 880

Ala Leu Gln Phe Gln Lys Ser Val Cys Glu Gly Ser Ser Ala Leu Lys  
 885 890 895

Thr Leu Glu Met Asn Pro Cys Thr Pro Asn Asn Val Glu Val Leu Glu  
 900 905 910

Thr Arg Ser Ala Phe Pro Lys Ile Glu Asp Thr Glu Ile Ile Ser Pro  
 915 920 925

Val Ala Glu Arg Pro Glu Asp Arg Ser Asp Ala Glu Pro Glu Asn His  
 930 935 940

Val Val Val Ser Tyr Cys Pro Pro Ile Ile Glu Glu Glu Ile Pro Asn  
 945 950 955 960

Pro Ala Ala Asp Glu Ala Gly Gly Thr Ala Gln Val Ile Tyr Ile Asp  
 965 970 975

Val Gln Ser Met Tyr Gln Pro Gln Ala Lys Pro Glu Glu Glu Gln Glu  
 980 985 990

Asn Asp Pro Val Gly Gly Ala Gly Tyr Lys Pro Gln Met His Leu Pro  
 995 1000 1005

Ile Asn Ser Thr Val Glu Asp Ile Ala Ala Glu Glu Asp Leu Asp  
 1010 1015 1020

Lys Thr Ala Gly Tyr Arg Pro Gln Ala Asn Val Asn Thr Trp Asn  
 1025 1030 1035

Leu Val Ser Pro Asp Ser Pro Arg Ser Ile Asp Ser Asn Ser Glu  
 1040 1045 1050

Ile Val Ser Phe Gly Ser Pro Cys Ser Ile Asn Ser Arg Gln Phe  
 1055 1060 1065

Leu Ile Pro Pro Lys Asp Glu Asp Ser Pro Lys Ser Asn Gly Gly  
 1070 1075 1080

Gly Trp Ser Phe Thr Asn Phe Phe Gln Asn Lys Pro Asn Asp  
 1085 1090 1095

<210> 7  
 <211> 979  
 <212> PRT  
 <213> Homo sapiens

<400> 7

Met Ala Leu Phe Ala Val Phe Gln Thr Thr Phe Phe Leu Thr Leu Leu  
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Ser Leu Arg Thr Tyr Gln Ser Glu Val Leu Ala Glu Arg Leu Pro Leu  
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Thr Pro Val Ser Leu Lys Val Ser Thr Asn Ser Thr Arg Gln Ser Leu  
 35 40 45

His Leu Gln Trp Thr Val His Asn Leu Pro Tyr His Gln Glu Leu Lys  
 50 55 60

Met Val Phe Gln Ile Gln Ile Ser Arg Ile Glu Thr Ser Asn Val Ile  
 65 70 75 80

Trp Val Gly Asn Tyr Ser Thr Thr Val Lys Trp Asn Gln Val Leu His  
 85 90 95

Trp Ser Trp Glu Ser Glu Leu Pro Leu Glu Cys Ala Thr His Phe Val  
 100 105 110

Arg Ile Lys Ser Leu Val Asp Asp Ala Lys Phe Pro Glu Pro Asn Phe  
 115 120 125

Trp Ser Asn Trp Ser Ser Trp Glu Glu Val Ser Val Gln Asp Ser Thr  
 130 135 140

Gly Gln Asp Ile Leu Phe Val Phe Pro Lys Asp Lys Leu Val Glu Glu  
 145 150 155 160

Gly Thr Asn Val Thr Ile Cys Tyr Val Ser Arg Asn Ile Gln Asn Asn  
 165 170 175

Val Ser Cys Tyr Leu Glu Gly Lys Gln Ile His Gly Glu Gln Leu Asp  
 180 185 190

Pro His Val Thr Ala Phe Asn Leu Asn Ser Val Pro Phe Ile Arg Asn  
 195 200 205

Lys Gly Thr Asn Ile Tyr Cys Glu Ala Ser Gln Gly Asn Val Ser Glu  
 210 215 220

Gly Met Lys Gly Ile Val Leu Phe Val Ser Lys Val Leu Glu Glu Pro  
 225 230 235 240

Lys Asp Phe Ser Cys Glu Thr Glu Asp Phe Lys Thr Leu His Cys Thr  
 245 250 255

Trp Asp Pro Gly Thr Asp Thr Ala Leu Gly Trp Ser Lys Gln Pro Ser  
 260 265 270

Gln Ser Tyr Thr Leu Phe Glu Ser Phe Ser Gly Glu Lys Lys Leu Cys  
 275 280 285

Thr His Lys Asn Trp Cys Asn Trp Gln Ile Thr Gln Asp Ser Gln Glu  
 290 295 300

Thr Tyr Asn Phe Thr Leu Ile Ala Glu Asn Tyr Leu Arg Lys Arg Ser  
 305 310 315 320

Val Asn Ile Leu Phe Asn Leu Thr His Arg Val Tyr Leu Met Asn Pro  
 325 330 335

Phe Ser Val Asn Phe Glu Asn Val Asn Ala Thr Asn Ala Ile Met Thr  
 340 345 350

Trp Lys Val His Ser Ile Arg Asn Asn Phe Thr Tyr Leu Cys Gln Ile  
 355 360 365

Glu Leu His Gly Glu Gly Lys Met Met Gln Tyr Asn Val Ser Ile Lys  
 370 375 380

Val Asn Gly Glu Tyr Phe Leu Ser Glu Leu Glu Pro Ala Thr Glu Tyr  
 385 390 395 400

Met Ala Arg Val Arg Cys Ala Asp Ala Ser His Phe Trp Lys Trp Ser  
 405 410 415

Glu Trp Ser Gly Gln Asn Phe Thr Thr Leu Glu Ala Ala Pro Ser Glu  
 420 425 430

Ala Pro Asp Val Trp Arg Ile Val Ser Leu Glu Pro Gly Asn His Thr  
 435 440 445

Val Thr Leu Phe Trp Lys Pro Leu Ser Lys Leu His Ala Asn Gly Lys  
 450 455 460

Ile Leu Phe Tyr Asn Val Val Val Glu Asn Leu Asp Lys Pro Ser Ser  
 465 470 475 480

Ser Glu Leu His Ser Ile Pro Ala Pro Ala Asn Ser Thr Lys Leu Ile  
 485 490 495

Leu Asp Arg Cys Ser Tyr Gln Ile Cys Val Ile Ala Asn Asn Ser Val  
 500 505 510

Gly Ala Ser Pro Ala Ser Val Ile Val Ile Ser Ala Asp Pro Glu Asn  
 515 520 525



Lys Glu Val Glu Glu Glu Arg Ile Ala Gly Thr Glu Gly Gly Phe Ser  
 530 535 540

Leu Ser Trp Lys Pro Gln Pro Gly Asp Val Ile Gly Tyr Val Val Asp  
 545 550 555 560

Trp Cys Asp His Thr Gln Asp Val Leu Gly Asp Phe Gln Trp Lys Asn  
 565 570 575

Val Gly Pro Asn Thr Thr Ser Thr Val Ile Ser Thr Asp Ala Phe Arg  
 580 585 590

Pro Gly Val Arg Tyr Asp Phe Arg Ile Tyr Gly Leu Ser Thr Lys Arg  
 595 600 605

Ile Ala Cys Leu Leu Glu Lys Lys Thr Gly Tyr Ser Gln Glu Leu Ala  
 610 615 620

Pro Ser Asp Asn Pro His Val Leu Val Asp Thr Leu Thr Ser His Ser  
 625 630 635 640

Phe Thr Leu Ser Trp Lys Asp Tyr Ser Thr Glu Ser Gln Pro Gly Phe  
 645 650 655

Ile Gln Gly Tyr His Val Tyr Leu Lys Ser Lys Ala Arg Gln Cys His  
 660 665 670

Pro Arg Phe Glu Lys Ala Val Leu Ser Asp Gly Ser Glu Cys Cys Lys  
 675 680 685

Tyr Lys Ile Asp Asn Pro Glu Glu Lys Ala Leu Ile Val Asp Asn Leu  
 690 695 700

Lys Pro Glu Ser Phe Tyr Glu Phe Phe Ile Thr Pro Phe Thr Ser Ala  
 705 710 715 720

Gly Glu Gly Pro Ser Ala Thr Phe Thr Lys Val Thr Thr Pro Asp Glu  
 725 730 735

His Ser Ser Met Leu Ile His Ile Leu Leu Pro Met Val Phe Cys Val  
 740 745 750

Leu Leu Ile Met Val Met Cys Tyr Leu Lys Ser Gln Trp Ile Lys Glu  
 755 760 765

Thr Cys Tyr Pro Asp Ile Pro Asp Pro Tyr Lys Ser Ser Ile Leu Ser

770                      775                      780  
 Leu Ile Lys Phe Lys Glu Asn Pro His Leu Ile Ile Met Asn Val Ser  
 785                      790                      795                      800  
 Asp Cys Ile Pro Asp Ala Ile Glu Val Val Ser Lys Pro Glu Gly Thr  
                     805                      810                      815  
 Lys Ile Gln Phe Leu Gly Thr Arg Lys Ser Leu Thr Glu Thr Glu Leu  
                     820                      825                      830  
 Thr Lys Pro Asn Tyr Leu Tyr Leu Leu Pro Thr Glu Lys Asn His Ser  
                     835                      840                      845  
 Gly Pro Gly Pro Cys Ile Cys Phe Glu Asn Leu Thr Tyr Asn Gln Ala  
                     850                      855                      860  
 Ala Ser Asp Ser Gly Ser Cys Gly His Val Pro Val Ser Pro Lys Ala  
 865                      870                      875  
 Pro Ser Met Leu Gly Leu Met Thr Ser Pro Glu Asn Val Leu Lys Ala  
                     885                      890                      895  
 Leu Glu Lys Asn Tyr Met Asn Ser Leu Gly Glu Ile Pro Ala Gly Glu  
                     900                      905                      910  
 Thr Ser Leu Asn Tyr Val Ser Gln Leu Ala Ser Pro Met Phe Gly Asp  
                     915                      920                      925  
 Lys Asp Ser Leu Pro Thr Asn Pro Val Glu Ala Pro His Cys Ser Glu  
                     930                      935                      940  
 Tyr Lys Met Gln Met Ala Val Ser Leu Arg Leu Ala Leu Pro Pro Pro  
 945                      950                      955                      960  
 Thr Glu Asn Ser Ser Leu Ser Ser Ile Thr Leu Leu Asp Pro Gly Glu  
                     965                      970                      975

His Tyr Cys

<210> 8  
 <211> 918  
 <212> PRT  
 <213> Homo sapiens

<400> 8

Met Leu Thr Leu Gln Thr Trp Val Val Gln Ala Leu Phe Ile Phe Leu  
 1 5 10 15  
 Thr Thr Glu Ser Thr Gly Glu Leu Leu Asp Pro Cys Gly Tyr Ile Ser  
 20 25 30  
 Pro Glu Ser Pro Val Val Gln Leu His Ser Asn Phe Thr Ala Val Cys  
 35 40 45  
 Val Leu Lys Glu Lys Cys Met Asp Tyr Phe His Val Asn Ala Asn Tyr  
 50 55 60  
 Ile Val Trp Lys Thr Asn His Phe Thr Ile Pro Lys Glu Gln Tyr Thr  
 65 70 75 80  
 Ile Ile Asn Arg Thr Ala Ser Ser Val Thr Phe Thr Asp Ile Ala Ser  
 85 90 95  
 Leu Asn Ile Gln Leu Thr Cys Asn Ile Leu Thr Phe Gly Gln Leu Glu  
 100 105 110  
 Gln Asn Val Tyr Gly Ile Thr Ile Ile Ser Gly Leu Pro Pro Glu Lys  
 115 120 125  
 Pro Lys Asn Leu Ser Cys Ile Val Asn Glu Gly Lys Lys Met Arg Cys  
 130 135 140  
 Glu Trp Asp Gly Gly Arg Glu Thr His Leu Glu Thr Asn Phe Thr Leu  
 145 150 155 160  
 Lys Ser Glu Trp Ala Thr His Lys Phe Ala Asp Cys Lys Ala Lys Arg  
 165 170 175  
 Asp Thr Pro Thr Ser Cys Thr Val Asp Tyr Ser Thr Val Tyr Phe Val  
 180 185 190  
 Asn Ile Glu Val Trp Val Glu Ala Glu Asn Ala Leu Gly Lys Val Thr  
 195 200 205  
 Ser Asp His Ile Asn Phe Asp Pro Val Tyr Lys Val Lys Pro Asn Pro  
 210 215 220  
 Pro His Asn Leu Ser Val Ile Asn Ser Glu Glu Leu Ser Ser Ile Leu  
 225 230 235 240

Lys Leu Thr Trp Thr Asn Pro Ser Ile Lys Ser Val Ile Ile Leu Lys  
 245 250 255  
 Tyr Asn Ile Gln Tyr Arg Thr Lys Asp Ala Ser Thr Trp Ser Gln Ile  
 260 265 270  
 Pro Pro Glu Asp Thr Ala Ser Thr Arg Ser Ser Phe Thr Val Gln Asp  
 275 280 285  
 Leu Lys Pro Phe Thr Glu Tyr Val Phe Arg Ile Arg Cys Met Lys Glu  
 290 295 300  
 Asp Gly Lys Gly Tyr Trp Ser Asp Trp Ser Glu Glu Ala Ser Gly Ile  
 305 310 315 320  
 Thr Tyr Glu Asp Arg Pro Ser Lys Ala Pro Ser Phe Trp Tyr Lys Ile  
 325 330 335  
 Asp Pro Ser His Thr Gln Gly Tyr Arg Thr Val Gln Leu Val Trp Lys  
 340 345 350  
 Thr Leu Pro Pro Phe Glu Ala Asn Gly Lys Ile Leu Asp Tyr Glu Val  
 355 360 365  
 Thr Leu Thr Arg Trp Lys Ser His Leu Gln Asn Tyr Thr Val Asn Ala  
 370 375 380  
 Thr Lys Leu Thr Val Asn Leu Thr Asn Asp Arg Tyr Leu Ala Thr Leu  
 385 390 395 400  
 Thr Val Arg Asn Leu Val Gly Lys Ser Asp Ala Ala Val Leu Thr Ile  
 405 410 415  
 Pro Ala Cys Asp Phe Gln Ala Thr His Pro Val Met Asp Leu Lys Ala  
 420 425 430  
 Phe Pro Lys Asp Asn Met Leu Trp Val Glu Trp Thr Thr Pro Arg Glu  
 435 440 445  
 Ser Val Lys Lys Tyr Ile Leu Glu Trp Cys Val Leu Ser Asp Lys Ala  
 450 455 460  
 Pro Cys Ile Thr Asp Trp Gln Gln Glu Asp Gly Thr Val His Arg Thr  
 465 470 475 480  
 Tyr Leu Arg Gly Asn Leu Ala Glu Ser Lys Cys Tyr Leu Ile Thr Val

19

Ser Arg Pro Ser Ile Ser Ser Ser Asp Glu Asn Glu Ser Ser Gln Asn  
740 745 750

Thr Ser Ser Thr Val Gln Tyr Ser Thr Val Val His Ser Gly Tyr Arg  
755 760 765

His Gln Val Pro Ser Val Gln Val Phe Ser Arg Ser Glu Ser Thr Gln  
770 775 780

Pro Leu Leu Asp Ser Glu Glu Arg Pro Glu Asp Leu Gln Leu Val Asp  
785 790 795 800

His Val Asp Gly Gly Asp Gly Ile Leu Pro Arg Gln Gln Tyr Phe Lys  
805 810 815

Gln Asn Cys Ser Gln His Glu Ser Ser Pro Asp Ile Ser His Phe Glu  
820 825 830

Arg Ser Lys Gln Val Ser Ser Val Asn Glu Glu Asp Phe Val Arg Leu  
835 840 845

Lys Gln Gln Ile Ser Asp His Ile Ser Gln Ser Cys Gly Ser Gly Gln  
850 855 860

Met Lys Met Phe Gln Glu Val Ser Ala Ala Asp Ala Phe Gly Pro Gly  
865 870 875 880

Thr Glu Gly Gln Val Glu Arg Phe Glu Thr Val Gly Met Glu Ala Ala  
885 890 895

Thr Asp Glu Gly Met Pro Lys Ser Tyr Leu Pro Gln Thr Val Arg Gln  
900 905 910

Gly Gly Tyr Met Pro Gln  
915

<210> 9

<211> 836

<212> PRT

<213> Homo sapiens

<400> 9

Met Ala Arg Leu Gly Asn Cys Ser Leu Thr Trp Ala Ala Leu Ile Ile  
1 5 10 15

Leu Leu Leu Pro Gly Ser Leu Glu Glu Cys Gly His Ile Ser Val Ser  
 20 25 30

Ala Pro Ile Val His Leu Gly Asp Pro Ile Thr Ala Ser Cys Ile Ile  
 35 40 45

Lys Gln Asn Cys Ser His Leu Asp Pro Glu Pro Gln Ile Leu Trp Arg  
 50 55 60

Leu Gly Ala Glu Leu Gln Pro Gly Gly Arg Gln Gln Arg Leu Ser Asp  
 65 70 75 80

Gly Thr Gln Glu Ser Ile Ile Thr Leu Pro His Leu Asn His Thr Gln  
 85 90 95

Ala Phe Leu Ser Cys Cys Leu Asn Trp Gly Asn Ser Leu Gln Ile Leu  
 100 105 110

Asp Gln Val Glu Leu Arg Ala Gly Tyr Pro Pro Ala Ile Pro His Asn  
 115 120 125

Leu Ser Cys Leu Met Asn Leu Thr Thr Ser Ser Leu Ile Cys Gln Trp  
 130 135 140

Glu Pro Gly Pro Glu Thr His Leu Pro Thr Ser Phe Thr Leu Lys Ser  
 145 150 155 160

Phe Lys Ser Arg Gly Asn Cys Gln Thr Gln Gly Asp Ser Ile Leu Asp  
 165 170 175

Cys Val Pro Lys Asp Gly Gln Ser His Cys Cys Ile Pro Arg Lys His  
 180 185 190

Leu Leu Leu Tyr Gln Asn Met Gly Ile Trp Val Gln Ala Glu Asn Ala  
 195 200 205

Leu Gly Thr Ser Met Ser Pro Gln Leu Cys Leu Asp Pro Met Asp Val  
 210 215 220

Val Lys Leu Glu Pro Pro Met Leu Arg Thr Met Asp Pro Ser Pro Glu  
 225 230 235 240

Ala Ala Pro Pro Gln Ala Gly Cys Leu Gln Leu Cys Trp Glu Pro Trp  
 245 250 255

Gln Pro Gly Leu His Ile Asn Gln Lys Cys Glu Leu Arg His Lys Pro

260	265	270
Gln Arg Gly Glu Ala Ser Trp Ala Leu Val Gly Pro Leu Pro Leu Glu		
275	280	285
Ala Leu Gln Tyr Glu Leu Cys Gly Leu Leu Pro Ala Thr Ala Tyr Thr		
290	295	300
Leu Gln Ile Arg Cys Ile Arg Trp Pro Leu Pro Gly His Trp Ser Asp		
305	310	315
Trp Ser Pro Ser Leu Glu Leu Arg Thr Thr Glu Arg Ala Pro Thr Val		
325	330	335
Arg Leu Asp Thr Trp Trp Arg Gln Arg Gln Leu Asp Pro Arg Thr Val		
340	345	350
Gln Leu Phe Trp Lys Pro Val Pro Leu Glu Glu Asp Ser Gly Arg Ile		
355	360	365
Gln Gly Tyr Val Val Ser Trp Arg Pro Ser Gly Gln Ala Gly Ala Ile		
370	375	380
Leu Pro Leu Cys Asn Thr Thr Glu Leu Ser Cys Thr Phe His Leu Pro		
385	390	395
Ser Glu Ala Gln Glu Val Ala Leu Val Ala Tyr Asn Ser Ala Gly Thr		
405	410	415
Ser Arg Pro Thr Pro Val Val Phe Ser Glu Ser Arg Gly Pro Ala Leu		
420	425	430
Thr Arg Leu His Ala Met Ala Arg Asp Pro His Ser Leu Trp Val Gly		
435	440	445
Trp Glu Pro Pro Asn Pro Trp Pro Gln Gly Tyr Val Ile Glu Trp Gly		
450	455	460
Leu Gly Pro Pro Ser Ala Ser Asn Ser Asn Lys Thr Trp Arg Met Glu		
465	470	475
Gln Asn Gly Arg Ala Thr Gly Phe Leu Leu Lys Glu Asn Ile Arg Pro		
485	490	495
Phe Gln Leu Tyr Glu Ile Ile Val Thr Pro Leu Tyr Gln Asp Thr Met		
500	505	510



Gly Pro Ser Gln His Val Tyr Ala Tyr Ser Gln Glu Met Ala Pro Ser  
 515 520 525

His Ala Pro Glu Leu His Leu Lys His Ile Gly Lys Thr Trp Ala Gln  
 530 535 540

Leu Glu Trp Val Pro Glu Pro Pro Glu Leu Gly Lys Ser Pro Leu Thr  
 545 550 555 560

His Tyr Thr Ile Phe Trp Thr Asn Ala Gln Asn Gln Ser Phe Ser Ala  
 565 570 575

Ile Leu Asn Ala Ser Ser Arg Gly Phe Val Leu His Gly Leu Glu Pro  
 580 585 590

Ala Ser Leu Tyr His Ile His Leu Met Ala Ala Ser Gln Ala Gly Ala  
 595 600 605

Thr Asn Ser Thr Val Leu Thr Leu Met Thr Leu Thr Pro Glu Gly Ser  
 610 615 620

Glu Leu His Ile Ile Leu Gly Leu Phe Gly Leu Leu Leu Leu Leu Thr  
 625 630 635 640

Cys Leu Cys Gly Thr Ala Trp Leu Cys Cys Ser Pro Asn Arg Lys Asn  
 645 650 655

Pro Leu Trp Pro Ser Val Pro Asp Pro Ala His Ser Ser Leu Gly Ser  
 660 665 670

Trp Val Pro Thr Ile Met Glu Glu Asp Ala Phe Gln Leu Pro Gly Leu  
 675 680 685

Gly Thr Pro Pro Ile Thr Lys Leu Thr Val Leu Glu Glu Asp Glu Lys  
 690 695 700

Lys Pro Val Pro Trp Glu Ser His Asn Ser Ser Glu Thr Cys Gly Leu  
 705 710 715 720

Pro Thr Leu Val Gln Thr Tyr Val Leu Gln Gly Asp Pro Arg Ala Val  
 725 730 735

Ser Thr Gln Pro Gln Ser Gln Ser Gly Thr Ser Asp Gln Val Leu Tyr  
 740 745 750

Gly Gln Leu Leu Gly Ser Pro Thr Ser Pro Gly Pro Gly His Tyr Leu  
 755 760 765

Arg Cys Asp Ser Thr Gln Pro Leu Leu Ala Gly Leu Thr Pro Ser Pro  
 770 775 780

Lys Ser Tyr Glu Asn Leu Trp Phe Gln Ala Ser Pro Leu Gly Thr Leu  
 785 790 795 800

Val Thr Pro Ala Pro Ser Gln Glu Asp Asp Cys Val Phe Gly Pro Leu  
 805 810 815

Leu Asn Phe Pro Leu Leu Gln Gly Ile Arg Val His Gly Met Glu Ala  
 820 825 830

Leu Gly Ser Phe  
 835

<210> 10  
 <211> 7  
 <212> PRT  
 <213> Homo sapiens

<400> 10

Trp Lys Ser Thr Ser Val Lys  
 1 5

<210> 11  
 <211> 15  
 <212> PRT  
 <213> Homo sapiens

<400> 11

Glu Gly Lys Leu Leu Pro Ala Ile Pro Val Leu Ser Ala Leu Lys  
 1 5 10 15

<210> 12  
 <211> 726  
 <212> PRT  
 <213> Mus musculus

<400> 12

Met Lys Pro Leu Gly Val Asn Ala Gly Ile Met Trp Thr Leu Ala Leu  
 1 5 10 15

Trp Ala Phe Ser Phe Leu Cys Lys Phe Ser Leu Ala Val Leu Pro Thr  
 20 25 30

Lys Pro Glu Asn Ile Ser Cys Val Phe Tyr Phe Asp Arg Asn Leu Thr  
 35 40 45  
 Cys Thr Trp Arg Pro Glu Lys Glu Thr Asn Asp Thr Ser Tyr Ile Val  
 50 55 60  
 Thr Leu Thr Tyr Ser Tyr Gly Lys Ser Asn Tyr Ser Asp Asn Ala Thr  
 65 70 75 80  
 Glu Ala Ser Tyr Ser Phe Pro Arg Ser Cys Ala Met Pro Pro Asp Ile  
 85 90 95  
 Cys Ser Val Glu Val Gln Ala Gln Asn Gly Asp Gly Lys Val Lys Ser  
 100 105 110  
 Asp Ile Thr Tyr Trp His Leu Ile Ser Ile Ala Lys Thr Glu Pro Pro  
 115 120 125  
 Ile Ile Leu Ser Val Asn Pro Ile Cys Asn Arg Met Phe Gln Ile Gln  
 130 135 140  
 Trp Lys Pro Arg Glu Lys Thr Arg Gly Phe Pro Leu Val Cys Met Leu  
 145 150 155 160  
 Arg Phe Arg Thr Val Asn Ser Ser Arg Trp Thr Glu Val Asn Phe Glu  
 165 170 175  
 Asn Cys Lys Gln Val Cys Asn Leu Thr Gly Leu Gln Ala Phe Thr Glu  
 180 185 190  
 Tyr Val Leu Ala Leu Arg Phe Arg Phe Asn Asp Ser Arg Tyr Trp Ser  
 195 200 205  
 Lys Trp Ser Lys Glu Glu Thr Arg Val Thr Met Glu Glu Val Pro His  
 210 215 220  
 Val Leu Asp Leu Trp Arg Ile Leu Glu Pro Ala Asp Met Asn Gly Asp  
 225 230 235 240  
 Arg Lys Val Arg Leu Leu Trp Lys Lys Ala Arg Gly Ala Pro Val Leu  
 245 250 255  
 Glu Lys Thr Phe Gly Tyr His Ile Gln Tyr Phe Ala Glu Asn Ser Thr  
 260 265 270

Asn Leu Thr Glu Ile Asn Asn Ile Thr Thr Gln Gln Tyr Glu Leu Leu  
 275 280 285

Leu Met Ser Gln Ala His Ser Val Ser Val Thr Ser Phe Asn Ser Leu  
 290 295 300

Gly Lys Ser Gln Glu Thr Ile Leu Arg Ile Pro Asp Val His Glu Lys  
 305 310 315 320

Thr Phe Gln Tyr Ile Lys Ser Met Gln Ala Tyr Ile Ala Glu Pro Leu  
 325 330 335

Leu Val Val Asn Trp Gln Ser Ser Ile Pro Ala Val Asp Thr Trp Ile  
 340 345 350

Val Glu Trp Leu Pro Glu Ala Ala Met Ser Lys Phe Pro Ala Leu Ser  
 355 360 365

Trp Glu Ser Val Ser Gln Val Thr Asn Trp Thr Ile Glu Gln Asp Lys  
 370 375 380

Leu Lys Pro Phe Thr Cys Tyr Asn Ile Ser Val Tyr Pro Val Leu Gly  
 385 390 395 400

His Arg Val Gly Glu Pro Tyr Ser Ile Gln Ala Tyr Ala Lys Glu Gly  
 405 410 415

Thr Pro Leu Lys Gly Pro Glu Thr Arg Val Glu Asn Ile Gly Leu Arg  
 420 425 430

Thr Ala Thr Ile Thr Trp Lys Glu Ile Pro Lys Ser Ala Arg Asn Gly  
 435 440 445

Phe Ile Asn Asn Tyr Thr Val Phe Tyr Gln Ala Glu Gly Gly Lys Glu  
 450 455 460

Leu Ser Lys Thr Val Asn Ser His Ala Leu Gln Cys Asp Leu Glu Ser  
 465 470 475 480

Leu Thr Arg Arg Thr Ser Tyr Thr Val Trp Val Met Ala Ser Thr Arg  
 485 490 495

Ala Gly Gly Thr Asn Gly Val Arg Ile Asn Phe Lys Thr Leu Ser Ile  
 500 505 510

Ser Val Phe Glu Val Val Leu Leu Thr Ser Leu Val Gly Gly Gly Leu

[illegible]

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<210> 13
<211> 252
<212> PRT
<213> Homo sapiens
<400> 13
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Met 1	Lys	Leu	Ser	Pro 5	Gln	Pro	Ser	Cys	Val 10	Asn	Leu	Gly	Met	Met 15	Trp
Thr	Trp	Ala	Leu 20	Trp	Met	Leu	Pro	Ser 25	Leu	Cys	Lys	Phe	Ser 30	Leu	Ala
Ala	Leu	Pro 35	Ala	Lys	Pro	Glu	Asn 40	Ile	Ser	Cys	Val	Tyr 45	Tyr	Tyr	Arg
Lys	Asn 50	Leu	Thr	Cys	Thr	Trp 55	Ser	Pro	Gly	Lys	Glu 60	Thr	Ser	Tyr	Thr
Gln 65	Tyr	Thr	Val	Lys 70	Arg	Thr	Tyr	Ala	Phe	Gly 75	Glu	Lys	His	Asp	Asn 80
Cys	Thr	Thr	Asn 85	Ser	Ser	Thr	Ser	Glu	Asn 90	Arg	Ala	Ser	Cys	Ser 95	Phe
Phe	Leu	Pro	Arg 100	Ile	Thr	Ile	Pro	Asp 105	Asn	Tyr	Thr	Ile	Glu 110	Val	Glu
Ala	Glu	Asn 115	Gly	Asp	Gly	Val	Ile 120	Lys	Ser	His	Met	Thr 125	Tyr	Trp	Arg
Leu	Glu 130	Asn	Ile	Ala	Lys	Thr 135	Glu	Pro	Pro	Lys	Ile 140	Phe	Arg	Val	Lys
Pro 145	Val	Leu	Gly	Ile 150	Lys	Arg	Met	Ile	Gln	Ile 155	Glu	Trp	Ile	Lys	Pro 160
Glu	Leu	Ala	Pro 165	Val	Ser	Ser	Asp	Leu	Lys 170	Tyr	Thr	Leu	Arg	Phe 175	Arg
Thr	Val	Asn 180	Ser	Thr	Ser	Trp	Met	Glu 185	Val	Asn	Phe	Ala	Lys 190	Asn	Arg
Lys	Asp 195	Lys	Asn	Gln	Thr	Tyr	Asn 200	Leu	Thr	Gly	Leu	Gln 205	Pro	Phe	Thr
Glu	Tyr 210	Val	Ile	Ala	Leu	Arg 215	Cys	Ala	Val	Lys	Glu 220	Ser	Lys	Phe	Trp
Ser 225	Asp	Trp	Ser	Gln 230	Glu	Lys	Met	Gly	Met	Thr 235	Glu	Glu	Glu	Gly	Lys 240

Leu Leu Pro Ala Ile Pro Val Leu Ser Thr Leu Val  
 245 250

<210> 14  
 <211> 652  
 <212> PRT  
 <213> Homo sapiens

<400> 14

Met Lys Leu Ser Pro Gln Pro Ser Cys Val Asn Leu Gly Met Met Trp  
 1 5 10 15

Thr Trp Ala Leu Trp Met Leu Pro Ser Leu Cys Lys Phe Ser Leu Ala  
 20 25 30

Ala Leu Pro Ala Lys Pro Glu Asn Ile Ser Cys Val Tyr Tyr Tyr Arg  
 35 40 45

Lys Asn Leu Thr Cys Thr Trp Ser Pro Gly Lys Glu Thr Ser Tyr Thr  
 50 55 60

Gln Tyr Thr Val Lys Arg Thr Tyr Ala Phe Gly Glu Lys His Asp Asn  
 65 70 75 80

Cys Thr Thr Asn Ser Ser Thr Ser Glu Asn Arg Ala Ser Cys Ser Phe  
 85 90 95

Phe Leu Pro Arg Ile Thr Ile Pro Asp Asn Tyr Thr Ile Glu Val Glu  
 100 105 110

Ala Glu Asn Gly Asp Gly Val Ile Lys Ser His Met Thr Tyr Trp Arg  
 115 120 125

Leu Glu Asn Ile Ala Lys Thr Glu Pro Pro Lys Ile Phe Arg Val Lys  
 130 135 140

Pro Val Leu Gly Ile Lys Arg Met Ile Gln Ile Glu Trp Ile Lys Pro  
 145 150 155 160

Glu Leu Ala Pro Val Ser Ser Asp Leu Lys Tyr Thr Leu Arg Phe Arg  
 165 170 175

Thr Val Asn Ser Thr Ser Trp Met Glu Val Asn Phe Ala Lys Asn Arg  
 180 185 190

Lys Asp Lys Asn Gln Thr Tyr Asn Leu Thr Gly Leu Gln Pro Phe Thr  
 195 200 205

Glu Tyr Val Ile Ala Leu Arg Cys Ala Val Lys Glu Ser Lys Phe Trp  
 210 215 220  
 Ser Asp Trp Ser Gln Glu Lys Met Gly Met Thr Glu Glu Glu Ala Pro  
 225 230 235 240  
 Cys Gly Leu Glu Leu Trp Arg Val Leu Lys Pro Ala Glu Ala Asp Gly  
 245 250 255  
 Arg Arg Pro Val Arg Leu Leu Trp Lys Lys Ala Arg Gly Ala Pro Val  
 260 265 270  
 Leu Glu Lys Thr Leu Gly Tyr Asn Ile Trp Tyr Tyr Pro Glu Ser Asn  
 275 280 285  
 Thr Asn Leu Thr Glu Thr Met Asn Thr Thr Asn Gln Gln Leu Glu Leu  
 290 295 300  
 His Leu Gly Gly Glu Ser Phe Trp Val Ser Met Ile Ser Tyr Asn Ser  
 305 310 315 320  
 Leu Gly Lys Ser Pro Val Ala Thr Leu Arg Ile Pro Ala Ile Gln Glu  
 325 330 335  
 Lys Ser Phe Gln Cys Ile Glu Val Met Gln Ala Cys Val Ala Glu Asp  
 340 345 350  
 Gln Leu Val Val Lys Trp Gln Ser Ser Ala Leu Asp Val Asn Thr Trp  
 355 360 365  
 Met Ile Glu Trp Phe Pro Asp Val Asp Ser Glu Pro Thr Thr Leu Ser  
 370 375 380  
 Trp Glu Ser Val Ser Gln Ala Thr Asn Trp Thr Ile Gln Gln Asp Lys  
 385 390 395 400  
 Leu Lys Pro Phe Trp Cys Tyr Asn Ile Ser Val Tyr Pro Met Leu His  
 405 410 415  
 Asp Lys Val Gly Glu Pro Tyr Ser Ile Gln Ala Tyr Ala Lys Glu Gly  
 420 425 430  
 Val Pro Ser Glu Gly Pro Glu Thr Lys Val Glu Asn Ile Gly Val Lys  
 435 440 445



Thr Val Thr Ile Thr Trp Lys Glu Ile Pro Lys Ser Glu Arg Lys Gly  
 450 455 460

Ile Ile Cys Asn Tyr Thr Ile Phe Tyr Gln Ala Glu Gly Gly Lys Gly  
 465 470 475 480

Phe Ser Lys Thr Val Asn Ser Ser Ile Leu Gln Tyr Gly Leu Glu Ser  
 485 490 495

Leu Lys Arg Lys Thr Ser Tyr Ile Val Gln Val Met Ala Asn Thr Ser  
 500 505 510

Ala Gly Gly Thr Asn Gly Thr Ser Ile Asn Phe Lys Thr Leu Ser Phe  
 515 520 525

Ser Val Phe Glu Ile Ile Leu Ile Thr Ser Leu Ile Gly Gly Gly Leu  
 530 535 540

Leu Ile Leu Ile Ile Leu Thr Val Ala Tyr Gly Leu Lys Lys Pro Asn  
 545 550 555 560

Lys Leu Thr His Leu Cys Trp Pro Thr Val Pro Asn Pro Ala Glu Ser  
 565 570 575

Ser Ile Ala Thr Trp His Gly Asp Asp Phe Lys Asp Lys Leu Asn Leu  
 580 585 590

Lys Glu Ser Asp Asp Ser Val Asn Thr Glu Asp Arg Ile Leu Lys Pro  
 595 600 605

Cys Ser Thr Pro Ser Asp Lys Leu Val Ile Asp Lys Leu Val Val Asn  
 610 615 620

Phe Gly Asn Val Leu Gln Glu Ile Phe Thr Asp Glu Ala Arg Thr Gly  
 625 630 635 640

Gln Glu Lys Gln Phe Arg Arg Gly Lys Glu Trp Asp  
 645 650

<210> 15  
 <211> 662  
 <212> PRT  
 <213> Homo sapiens

<400> 15

Met Lys Leu Ser Pro Gln Pro Ser Cys Val Asn Leu Gly Met Met Trp

1	5	10	15
Thr Trp Ala Leu Trp Met Leu Pro Ser Leu Cys Lys Phe Ser Leu Ala	20	25	30
Ala Leu Pro Ala Lys Pro Glu Asn Ile Ser Cys Val Tyr Tyr Tyr Arg	35	40	45
Lys Asn Leu Thr Cys Thr Trp Ser Pro Gly Lys Glu Thr Ser Tyr Thr	50	55	60
Gln Tyr Thr Val Lys Arg Thr Tyr Ala Phe Gly Glu Lys His Asp Asn	65	70	75
Cys Thr Thr Asn Ser Ser Thr Ser Glu Asn Arg Ala Ser Cys Ser Phe	85	90	95
Phe Leu Pro Arg Ile Thr Ile Pro Asp Asn Tyr Thr Ile Glu Val Glu	100	105	110
Ala Glu Asn Gly Asp Gly Val Ile Lys Ser His Met Thr Tyr Trp Arg	115	120	125
Leu Glu Asn Ile Ala Lys Thr Glu Pro Pro Lys Ile Phe Arg Val Lys	130	135	140
Pro Val Leu Gly Ile Lys Arg Met Ile Gln Ile Glu Trp Ile Lys Pro	145	150	155
Glu Leu Ala Pro Val Ser Ser Asp Leu Lys Tyr Thr Leu Arg Phe Arg	165	170	175
Thr Val Asn Ser Thr Ser Trp Met Glu Val Asn Phe Ala Lys Asn Arg	180	185	190
Lys Asp Lys Asn Gln Thr Tyr Asn Leu Thr Gly Leu Gln Pro Phe Thr	195	200	205
Glu Tyr Val Ile Ala Leu Arg Cys Ala Val Lys Glu Ser Lys Phe Trp	210	215	220
Ser Asp Trp Ser Gln Glu Lys Met Gly Met Thr Glu Glu Glu Ala Pro	225	230	235
Cys Gly Leu Glu Leu Trp Arg Val Leu Lys Pro Ala Glu Ala Asp Gly	245	250	255

Arg Arg Pro Val Arg Leu Leu Trp Lys Lys Ala Arg Gly Ala Pro Val  
 260 265 270

Leu Glu Lys Thr Leu Gly Tyr Asn Ile Trp Tyr Tyr Pro Glu Ser Asn  
 275 280 285

Thr Asn Leu Thr Glu Thr Met Asn Thr Thr Asn Gln Gln Leu Glu Leu  
 290 295 300

His Leu Gly Gly Glu Ser Phe Trp Val Ser Met Ile Ser Tyr Asn Ser  
 305 310 315 320

Leu Gly Lys Ser Pro Val Ala Thr Leu Arg Ile Pro Ala Ile Gln Glu  
 325 330 335

Lys Ser Phe Gln Cys Ile Glu Val Met Gln Ala Cys Val Ala Glu Asp  
 340 345 350

Gln Leu Val Val Lys Trp Gln Ser Ser Ala Leu Asp Val Asn Thr Trp  
 355 360 365

Met Ile Glu Trp Phe Pro Asp Val Asp Ser Glu Pro Thr Thr Leu Ser  
 370 375 380

Trp Glu Ser Val Ser Gln Ala Thr Asn Trp Thr Ile Gln Gln Asp Lys  
 385 390 395 400

Leu Lys Pro Phe Trp Cys Tyr Asn Ile Ser Val Tyr Pro Met Leu His  
 405 410 415

Asp Lys Val Gly Glu Pro Tyr Ser Ile Gln Ala Tyr Ala Lys Glu Gly  
 420 425 430

Val Pro Ser Glu Gly Pro Glu Thr Lys Val Glu Asn Ile Gly Val Lys  
 435 440 445

Thr Val Thr Ile Thr Trp Lys Glu Ile Pro Lys Ser Glu Arg Lys Gly  
 450 455 460

Ile Ile Cys Asn Tyr Thr Ile Phe Tyr Gln Ala Glu Gly Gly Lys Gly  
 465 470 475 480

Phe Ser Lys Thr Val Asn Ser Ser Ile Leu Gln Tyr Gly Leu Glu Ser  
 485 490 495

Leu Lys Arg Lys Thr Ser Tyr Ile Val Gln Val Met Ala Ser Thr Ser  
 500 505 510

Ala Gly Gly Thr Asn Gly Thr Ser Ile Asn Phe Lys Thr Leu Ser Phe  
 515 520 525

Ser Val Phe Glu Ile Ile Leu Ile Thr Ser Leu Ile Gly Gly Gly Leu  
 530 535 540

Leu Ile Leu Ile Ile Leu Thr Val Ala Tyr Gly Leu Lys Lys Pro Asn  
 545 550 555 560

Lys Leu Thr His Leu Cys Trp Pro Thr Val Pro Asn Pro Ala Glu Ser  
 565 570 575

Ser Ile Ala Thr Trp His Gly Asp Asp Phe Lys Asp Lys Leu Asn Leu  
 580 585 590

Lys Glu Ser Asp Asp Ser Val Asn Thr Glu Asp Arg Ile Leu Lys Pro  
 595 600 605

Cys Ser Thr Pro Ser Asp Lys Leu Val Ile Asp Lys Leu Val Val Asn  
 610 615 620

Phe Gly Asn Val Leu Gln Glu Ile Phe Thr Asp Glu Ala Arg Thr Gly  
 625 630 635 640

Gln Glu Asn Asn Leu Gly Gly Glu Lys Asn Gly Thr Arg Ile Leu Ser  
 645 650 655

Ser Cys Pro Thr Ser Ile  
 660

<210> 16  
 <211> 344  
 <212> PRT  
 <213> Homo sapiens

<400> 16

Asn Pro Lys Asn Glu Ser Ser Glu Asn Ile Arg Glu Arg Leu Ser Leu  
 1 5 10 15

Pro Ser Thr Leu Gln Gln Asn Phe Gly Thr Leu Asn Phe Trp Phe Gln  
 20 25 30

Arg Ser His Asn Phe His Asn Leu Thr Thr Glu Glu Gly Pro Ser Thr

35	40	45	
Pro Ile Gly Thr Leu Lys	Pro Gly Leu Val Ile Lys	Ala Val Arg Lys	
50	55	60	
Leu Leu Met Asn Asp Ser Asp Gln Gly Gly Lys Leu Thr Thr Gly Val			
65	70	75	80
Phe Thr Pro Gln Gln Leu Ala Asn Thr Thr Asn Gln Gly Leu Ser Arg			
	85	90	95
Cys Leu Ser Arg Phe Lys Lys Val Ile Arg Ala Met Leu Met Met Lys			
	100	105	110
Ile Lys Leu Lys Arg Ile Thr Asn Ile Asn Cys Ser Gly His Ile Trp			
	115	120	125
Val Glu Pro Ala Thr Ile Phe Lys Met Gly Met Asn Ile Ser Ile Tyr			
	130	135	140
Cys Gln Ala Ala Ile Lys Asn Cys Gln Pro Arg Lys Leu His Phe Tyr			
145	150	155	160
Lys Asn Gly Ile Lys Glu Arg Phe Gln Ile Thr Arg Ile Asn Lys Thr			
	165	170	175
Thr Ala Arg Leu Trp Tyr Lys Asn Phe Leu Glu Pro His Ala Ser Met			
	180	185	190
Tyr Cys Thr Ala Glu Cys Pro Lys His Phe Gln Glu Thr Leu Ile Cys			
	195	200	205
Gly Lys Asp Ile Ser Ser Gly Phe Cys Ile Thr Asp Tyr Ser Gln Lys			
	210	215	220
Pro Ser Gln Val Leu Ala Gly Gly Pro Leu Ser Pro Asn Pro Thr Pro			
225	230	235	240
Gly Asn Val Glu Asp Pro Pro Asp Ile Pro Asp Glu Val Thr Cys Val			
	245	250	255
Ile Tyr Glu Tyr Ser Gly Asn Met Thr Cys Thr Trp Asn Ala Gly Lys			
	260	265	270
Leu Thr Tyr Ile Asp Thr Lys Tyr Val Val His Val Lys Ser Leu Glu			
	275	280	285

Thr Glu Glu Glu Gln Gln Tyr Leu Thr Ser Ser Tyr Ile Asn Ile Ser  
 290 295 300

Thr Asp Ser Leu Gln Gly Gly Lys Lys Tyr Leu Val Trp Val Gln Ala  
 305 310 315 320

Ala Asn Ala Leu Gly Met Glu Glu Ser Lys Gln Leu Gln Ile His Leu  
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Asp Asp Ile Ala Pro His Glu Arg  
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<210> 17  
 <211> 39  
 <212> PRT  
 <213> Homo sapiens

<400> 17

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Ser Gln Ile Phe Gly Thr Val  
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<210> 18  
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 <212> PRT  
 <213> Homo sapiens

<400> 18

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<210> 19  
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 <212> DNA  
 <213> Homo sapiens

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<210> 20  
 <211> 1890  
 <212> DNA  
 <213> Homo sapiens

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agtgaacta ttccagaaca gaccctgctt cctgatgaat ttgtctcctg tttggggatc    1800
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<210> 21  
 <211> 629  
 <212> PRT  
 <213> Homo sapiens

<400> 21

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Met Asn Gln Val Thr Ile Gln Trp Asp Ala Val Ile Ala Leu Tyr Ile
1           5           10          15

```

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Leu Phe Ser Trp Cys His Gly Gly Ile Thr Asn Ile Asn Cys Ser Gly
          20          25          30

```

```

His Ile Trp Val Glu Pro Ala Thr Ile Phe Lys Met Gly Met Asn Ile
          35          40          45

```

```

Ser Ile Tyr Cys Gln Ala Ala Ile Lys Asn Cys Gln Pro Arg Lys Leu
          50          55          60

```

His Phe Tyr Lys Asn Gly Ile Lys Glu Arg Phe Gln Ile Thr Arg Ile  
 65 70 75 80  
 Asn Lys Thr Thr Ala Arg Leu Trp Tyr Lys Asn Phe Leu Glu Pro His  
 85 90 95  
 Ala Ser Met Tyr Cys Thr Ala Glu Cys Pro Lys His Phe Gln Glu Thr  
 100 105 110  
 Leu Ile Cys Gly Lys Asp Ile Ser Ser Gly Tyr Pro Pro Asp Ile Pro  
 115 120 125  
 Asp Glu Val Thr Cys Val Ile Tyr Glu Tyr Ser Gly Asn Met Thr Cys  
 130 135 140  
 Thr Trp Asn Ala Gly Lys Leu Thr Tyr Ile Asp Thr Lys Tyr Val Val  
 145 150 155 160  
 His Val Lys Ser Leu Glu Thr Glu Glu Glu Gln Gln Tyr Leu Thr Ser  
 165 170 175  
 Ser Tyr Ile Asn Ile Ser Thr Asp Ser Leu Gln Gly Gly Lys Lys Tyr  
 180 185 190  
 Leu Val Trp Val Gln Ala Ala Asn Ala Leu Gly Met Glu Glu Ser Lys  
 195 200 205  
 Gln Leu Gln Ile His Leu Asp Asp Ile Val Ile Pro Ser Ala Ala Val  
 210 215 220  
 Ile Ser Arg Ala Glu Thr Ile Asn Ala Thr Val Pro Lys Thr Ile Ile  
 225 230 235 240  
 Tyr Trp Asp Ser Gln Thr Thr Ile Glu Lys Val Ser Cys Glu Met Arg  
 245 250 255  
 Tyr Lys Ala Thr Thr Asn Gln Thr Trp Asn Val Lys Glu Phe Asp Thr  
 260 265 270  
 Asn Phe Thr Tyr Val Gln Gln Ser Glu Phe Tyr Leu Glu Pro Asn Ile  
 275 280 285  
 Lys Tyr Val Phe Gln Val Arg Cys Gln Glu Thr Gly Lys Arg Tyr Trp  
 290 295 300

Gln Pro Trp Ser Ser Leu Phe Phe His Lys Thr Pro Glu Thr Val Pro  
 305 310 315 320  
 Gln Val Thr Ser Lys Ala Phe Gln His Asp Thr Trp Asn Ser Gly Leu  
 325 330 335  
 Thr Val Ala Ser Ile Ser Thr Gly His Leu Thr Ser Asp Asn Arg Gly  
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 Asp Ile Gly Leu Leu Leu Gly Met Ile Val Phe Ala Val Met Leu Ser  
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 370 375 380  
 Lys Arg Arg Ile Leu Leu Leu Ile Pro Lys Trp Leu Tyr Glu Asp Ile  
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 Glu Leu Met Asn Asn Asn Ser Ser Glu Gln Val Leu Tyr Val Asp Pro  
 420 425 430  
 Met Ile Thr Glu Ile Lys Glu Ile Phe Ile Pro Glu His Lys Pro Thr  
 435 440 445  
 Asp Tyr Lys Lys Glu Asn Thr Gly Pro Leu Glu Thr Arg Asp Tyr Pro  
 450 455 460  
 Gln Asn Ser Leu Phe Asp Asn Thr Thr Val Val Tyr Ile Pro Asp Leu  
 465 470 475 480  
 Asn Thr Gly Tyr Lys Pro Gln Ile Ser Asn Phe Leu Pro Glu Gly Ser  
 485 490 495  
 His Leu Ser Asn Asn Asn Glu Ile Thr Ser Leu Thr Leu Lys Pro Pro  
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 Val Asp Ser Leu Asp Ser Gly Asn Asn Pro Arg Leu Gln Lys His Pro  
 515 520 525  
 Asn Phe Ala Phe Ser Val Ser Ser Val Asn Ser Leu Ser Asn Thr Ile  
 530 535 540  
 Phe Leu Gly Glu Leu Ser Leu Ile Leu Asn Gln Gly Glu Cys Ser Ser

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cacaagccta cagactacaa gaaggagaat acaggacccc tggagacaag agactacccg 1200
caaaactcgc tattcgacaa tactacagtt gtatatattc ctgatctcaa cactggatat 1260
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<210> 23
<211> 565
<212> PRT
<213> Homo sapiens

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<400> 23

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Met Asn Gln Val Thr Ile Gln Trp Asp Ala Val Ile Ala Leu Tyr Ile
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Leu Phe Ser Trp Cys His Gly Gly Ile Thr Asn Ile Asn Cys Ser Gly
          20           25           30

```

```

His Ile Trp Val Glu Pro Ala Thr Ile Phe Lys Met Gly Met Asn Ile
          35           40           45

```

```

Ser Ile Tyr Cys Gln Ala Ala Ile Lys Asn Cys Gln Pro Arg Lys Leu
          50           55           60

```

```

His Phe Tyr Lys Asn Gly Ile Lys Glu Arg Phe Gln Ile Thr Arg Ile
65           70           75           80

```

```

Asn Lys Thr Thr Ala Arg Leu Trp Tyr Lys Asn Phe Leu Glu Pro His
          85           90           95

```

```

Ala Ser Met Tyr Cys Thr Ala Glu Cys Pro Lys His Phe Gln Glu Thr
          100          105          110

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Leu Ile Cys Gly Lys Asp Ile Ser Ser Gly Tyr Pro Pro Asp Ile Pro  
 115 120 125

Asp Glu Val Thr Cys Val Ile Tyr Glu Tyr Ser Gly Asn Met Thr Cys  
 130 135 140

Thr Trp Asn Ala Gly Lys Leu Thr Tyr Ile Asp Thr Lys Tyr Val Val  
 145 150 155 160

His Val Lys Ser Leu Glu Thr Glu Glu Gln Gln Tyr Leu Thr Ser  
 165 170 175

Ser Tyr Ile Asn Ile Ser Thr Asp Ser Leu Gln Gly Gly Lys Lys Tyr  
 180 185 190

Leu Val Trp Val Gln Ala Ala Asn Ala Leu Gly Met Glu Glu Ser Lys  
 195 200 205

Gln Leu Gln Ile His Leu Asp Asp Ile Val Ile Pro Ser Ala Ala Val  
 210 215 220

Ile Ser Arg Ala Glu Thr Ile Asn Ala Thr Val Pro Lys Thr Ile Ile  
 225 230 235 240

Tyr Trp Asp Ser Gln Thr Thr Ile Glu Lys Val Ser Cys Glu Met Arg  
 245 250 255

Tyr Lys Ala Thr Thr Asn Gln Thr Trp Asn Val Lys Glu Phe Asp Thr  
 260 265 270

Asn Phe Thr Tyr Val Gln Gln Ser Glu Phe Tyr Leu Glu Pro Asn Ile  
 275 280 285

Lys Tyr Val Phe Gln Val Arg Cys Gln Glu Thr Gly Lys Arg Tyr Trp  
 290 295 300

Gln Pro Trp Ser Ser Leu Phe Phe His Lys Thr Pro Glu Thr Gly Ile  
 305 310 315 320

Lys Arg Arg Ile Leu Leu Leu Ile Pro Lys Trp Leu Tyr Glu Asp Ile  
 325 330 335

Pro Asn Met Lys Asn Ser Asn Val Val Lys Met Leu Gln Glu Asn Ser  
 340 345 350

Glu Leu Met Asn Asn Asn Ser Ser Glu Gln Val Leu Tyr Val Asp Pro  
 355 360 365

Met Ile Thr Glu Ile Lys Glu Ile Phe Ile Pro Glu His Lys Pro Thr  
 370 375 380

Asp Tyr Lys Lys Glu Asn Thr Gly Pro Leu Glu Thr Arg Asp Tyr Pro  
 385 390 395 400

Gln Asn Ser Leu Phe Asp Asn Thr Thr Val Val Tyr Ile Pro Asp Leu  
 405 410 415

Asn Thr Gly Tyr Lys Pro Gln Ile Ser Asn Phe Leu Pro Glu Gly Ser  
 420 425 430

His Leu Ser Asn Asn Asn Glu Ile Thr Ser Leu Thr Leu Lys Pro Pro  
 435 440 445

Val Asp Ser Leu Asp Ser Gly Asn Asn Pro Arg Leu Gln Lys His Pro  
 450 455 460

Asn Phe Ala Phe Ser Val Ser Ser Val Asn Ser Leu Ser Asn Thr Ile  
 465 470 475 480

Phe Leu Gly Glu Leu Ser Leu Ile Leu Asn Gln Gly Glu Cys Ser Ser  
 485 490 495

Pro Asp Ile Gln Asn Ser Val Glu Glu Glu Thr Thr Met Leu Leu Glu  
 500 505 510

Asn Asp Ser Pro Ser Glu Thr Ile Pro Glu Gln Thr Leu Leu Pro Asp  
 515 520 525

Glu Phe Val Ser Cys Leu Gly Ile Val Asn Glu Glu Leu Pro Ser Ile  
 530 535 540

Asn Thr Tyr Phe Pro Gln Asn Ile Leu Glu Ser His Phe Asn Arg Ile  
 545 550 555 560

Ser Leu Leu Glu Lys  
 565

<210> 24  
 <211> 1071  
 <212> DNA  
 <213> Homo sapiens

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<400> 24
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<210> 25
<211> 356
<212> PRT
<213> Homo sapiens

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<400> 25

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Met Asn Gln Val Thr Ile Gln Trp Asp Ala Val Ile Ala Leu Tyr Ile
1           5           10           15

```

```

Leu Phe Ser Trp Cys His Gly Gly Ile Thr Asn Ile Asn Cys Ser Gly
20           25           30

```

```

His Ile Trp Val Glu Pro Ala Thr Ile Phe Lys Met Gly Met Asn Ile
35           40           45

```

```

Ser Ile Tyr Cys Gln Ala Ala Ile Lys Asn Cys Gln Pro Arg Lys Leu
50           55           60

```



His Phe Tyr Lys Asn Gly Ile Lys Glu Arg Phe Gln Ile Thr Arg Ile  
 65 70 75 80  
 Asn Lys Thr Thr Ala Arg Leu Trp Tyr Lys Asn Phe Leu Glu Pro His  
 85 90 95  
 Ala Ser Met Tyr Cys Thr Ala Glu Cys Pro Lys His Phe Gln Glu Thr  
 100 105 110  
 Leu Ile Cys Gly Lys Asp Ile Ser Ser Gly Tyr Pro Pro Asp Ile Pro  
 115 120 125  
 Asp Glu Val Thr Cys Val Ile Tyr Glu Tyr Ser Gly Asn Met Thr Cys  
 130 135 140  
 Thr Trp Asn Ala Gly Lys Leu Thr Tyr Ile Asp Thr Lys Tyr Val Val  
 145 150 155 160  
 His Val Lys Ser Leu Glu Thr Glu Glu Glu Gln Gln Tyr Leu Thr Ser  
 165 170 175  
 Ser Tyr Ile Asn Ile Ser Thr Asp Ser Leu Gln Gly Gly Lys Lys Tyr  
 180 185 190  
 Leu Val Trp Val Gln Ala Ala Asn Ala Leu Gly Met Glu Glu Ser Lys  
 195 200 205  
 Gln Leu Gln Ile His Leu Asp Asp Ile Val Ile Pro Ser Ala Ala Val  
 210 215 220  
 Ile Ser Arg Ala Glu Thr Ile Asn Ala Thr Val Pro Lys Thr Ile Ile  
 225 230 235 240  
 Tyr Trp Asp Ser Gln Thr Thr Ile Glu Lys Val Ser Cys Glu Met Arg  
 245 250 255  
 Tyr Lys Ala Thr Thr Asn Gln Thr Trp Asn Val Lys Glu Phe Asp Thr  
 260 265 270  
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 275 280 285  
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<210> 26
<211> 384
<212> PRT
<213> Homo sapiens
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<400> 26

Met Asn Gln Val Thr Ile Gln Trp Asp Ala Val Ile Ala Leu Tyr Ile  
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20 25 30

His Ile Trp Val Glu Pro Ala Thr Ile Phe Lys Met Gly Met Asn Ile  
35 40 45

Ser Ile Tyr Cys Gln Ala Ala Ile Lys Asn Cys Gln Pro Arg Lys Leu  
50 55 60

His Phe Tyr Lys Asn Gly Ile Lys Glu Arg Phe Gln Ile Thr Arg Ile  
65 70 75 80

Asn Lys Thr Thr Ala Arg Leu Trp Tyr Lys Asn Phe Leu Glu Pro His  
85 90 95

Ala Ser Met Tyr Cys Thr Ala Glu Cys Pro Lys His Phe Gln Glu Thr  
100 105 110

Leu Ile Cys Gly Lys Asp Ile Ser Ser Gly Tyr Pro Pro Asp Ile Pro  
115 120 125

Asp Glu Val Thr Cys Val Ile Tyr Glu Tyr Ser Gly Asn Met Thr Cys  
130 135 140

Thr Trp Asn Ala Gly Lys Leu Thr Tyr Ile Asp Thr Lys Tyr Val Val  
145 150 155 160

His Val Lys Ser Leu Glu Thr Glu Glu Glu Gln Gln Tyr Leu Thr Ser  
 165 170 175  
 Ser Tyr Ile Asn Ile Ser Thr Asp Ser Leu Gln Gly Gly Lys Lys Tyr  
 180 185 190  
 Leu Val Trp Val Gln Ala Ala Asn Ala Leu Gly Met Glu Glu Ser Lys  
 195 200 205  
 Gln Leu Gln Ile His Leu Asp Asp Ile Val Ile Pro Ser Ala Ala Val  
 210 215 220  
 Ile Ser Arg Ala Glu Thr Ile Asn Ala Thr Val Pro Lys Thr Ile Ile  
 225 230 235 240  
 Tyr Trp Asp Ser Gln Thr Thr Ile Glu Lys Val Ser Cys Glu Met Arg  
 245 250 255  
 Tyr Lys Ala Thr Thr Asn Gln Thr Trp Asn Val Lys Glu Phe Asp Thr  
 260 265 270  
 Asn Phe Thr Tyr Val Gln Gln Ser Glu Phe Tyr Leu Glu Pro Asn Ile  
 275 280 285  
 Lys Tyr Val Phe Gln Val Arg Cys Gln Glu Thr Gly Lys Arg Tyr Trp  
 290 295 300  
 Gln Pro Trp Ser Ser Pro Phe Phe His Lys Thr Pro Glu Thr Val Pro  
 305 310 315 320  
 Gln Val Thr Ser Lys Ala Phe Gln His Asp Thr Trp Asn Ser Gly Leu  
 325 330 335  
 Thr Val Ala Ser Ile Ser Thr Gly His Leu Thr Ser Asp Asn Arg Gly  
 340 345 350  
 Asp Ile Gly Leu Leu Leu Gly Met Ile Val Phe Ala Val Met Leu Ser  
 355 360 365  
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 370 375 380

<210> 27  
 <211> 644  
 <212> PRT  
 <213> Mus musculus

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## INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 01/31634

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 C12N15/12 C07K14/705 C07K14/715

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C07K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

WPI Data, PAJ, EPO-Internal, MEDLINE, CHEM ABS Data, BIOSIS, SEQUENCE SEARCH, EMB

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 98 31811 A (DONALDSON DEBRA D ;GENETICS INST (US); COLLINS MARY (US); NEBEN TA) 23 July 1998 (1998-07-23) the whole document	1,5-7, 12-35
Y	--- LARSEN A ET AL: "EXPRESSION CLONING OF A HUMAN GRANULOCYTE COLONY-STIMULATING FACTORRECEPTOR: A STRUCTURAL MOSAIC OF HEMATOPOIETIN RECEPTOR, IMMUNOGLOBULIN, AND FIBRONECTIN DOMAINS" JOURNAL OF EXPERIMENTAL MEDICINE, TOKYO, JP, vol. 172, 1 December 1990 (1990-12-01), pages 1559-1570, XP000611514 ISSN: 0022-1007 the whole document --- -/--	1,5-7, 12-35

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

## \* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&amp;" document member of the same patent family

Date of the actual completion of the international search

9 August 2002

Date of mailing of the international search report

13. 11. 02

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
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Fax: (+31-70) 340-3016

Authorized officer

Armandola, E

## INTERNATIONAL SEARCH REPORT

Internat'l Application No

PCT/JP 01/31634

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,Y	<p>DATABASE EMBL [Online]            SEQ. ID. NO: 17,            26 March 2001 (2001-03-26)            MAEDA M. AND YAGUCHI N.: "Human            haematopoietin receptor protein NR10.3"            Database accession no. AAB51244            XP002209359            the whole document</p>	1,5-7, 12-35
P,X	<p>-&amp; WO 00 75314 A (CHUGAI RES INST FOR            MOLECULAR ;MAEDA MASATSUGU (JP); YAGUCHI            NORIK) 14 December 2000 (2000-12-14)            ---</p>	1,5-7, 12-35
E	<p>WO 02 00721 A (ZYMOGENETICS INC)            3 January 2002 (2002-01-03)            SEQ. ID. NO: 1 and SEQ. ID. NO: 46            ---</p>	1,5-7, 12-35
L	<p>DATABASE EMBL [Online]            Sequence 1 from patent W00200721,            15 February 2002 (2002-02-15)            SPRECHER C.A. ET AL.: "Cytokine receptor            zcytor17"            Database accession no. AX365149            XP002209360            the whole document</p>	
L	<p>-&amp; DATABASE EMBL [Online]            Human zcytor17 protein sequence            SEQ.ID.NO:46, 1 May 2002 (2002-05-01)            SPRECHER C.A. ET AL.: "Isolated            polynucleotide encoding a cytokine            receptor zcytor17."            Database accession no. AAB05730            XP002209361            L document cited to provide information on            the relevant sequence disclosed in            W00200721            the whole document</p>	
E	<p>WO 01 93983 A (STEPHAN JEAN PHILIPPE F            ;BAKER KEVIN P (US); DESNOYERS LUC (US);            G) 13 December 2001 (2001-12-13)            SEQ. ID. NO: 91 and NO: 92            ---</p>	1,5-7, 12-35
	<p>---            -/--</p>	

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 01/31634

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
L	<p>DATABASE EMBL [Online] Sequence 91 from patent W00193983, 13 February 2002 (2002-02-13) BAKER K.P. ET AL.: "Secreted transmembrane polypeptides and nucleic acids encoding the same." Database accession no. AX358838 XP002209362 the whole document</p>	
L	<p>-&amp; DATABASE EMBL [Online] Sequence 92 from Patent W00193983, 13 February 2002 (2002-02-13) BAKER K.P. ET AL.: "Secreted and transmembrane polypeptides and nucleic acids encoding the same" Database accession no. AX358839 XP002209363 L document cited to provide information on the relevant sequence disclosed in W00193983 the whole document -----</p>	

# INTERNATIONAL SEARCH REPORT

Int ional application No.  
PCT/US 01/31634

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☒ Claims Nos.: 28,30-35  
because they relate to subject matter not required to be searched by this Authority, namely:  
Although claims 28 and 30-35 are directed to a method of treatment of the human/animal body, the search has been carried out and based on the alleged effects of the compound/composition.
2. ☒ Claims Nos.: 5,12-15,18, 27-30, 32-35  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:  
see FURTHER INFORMATION sheet PCT/ISA/210
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:  
1,5,12-35(partially), 6,7 (completely)

### Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.  
☐ No protest accompanied the payment of additional search fees.

## FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1, 5, 12-35 (partially), 6,7 (completely)

An isolated polypeptide HPR1 comprising the amino acid sequence of SEQ. ID. NO: 4, subsequences thereof, fusions of subsequences of SEQ. ID. NO: 4, isolated polynucleotides encoding the polypeptides or comprising the nucleotide sequences SEQ. ID. NO: 3, SEQ. ID. NO: 5 and subsequences thereof, expression vectors and host cells containing these sequences, processes for producing the polypeptides, antibodies binding to the polypeptides, methods for identifying modulators, methods of treatment utilizing the polypeptides.

2. Claims: 1,5,12-35 (all partially)

HPR1 amino acid sequences comprising fragments of SEQ. ID. NO: 4 fused to fragments of SEQ. ID. NO: 1, isolated polynucleotides encoding the polypeptides, expression vectors and host cells containing these sequences, processes for producing the polypeptides, antibodies binding to the polypeptides, methods for identifying modulators, methods of treatment utilizing the polypeptides.

3. Claims: 1,5,12-35 (all partially)

HPR1 amino acid sequences comprising fragments of SEQ. ID. NO: 4 fused to fragments of SEQ. ID. NO: 2, isolated polynucleotides encoding the polypeptides, expression vectors and host cells containing these sequences, processes for producing the polypeptides, antibodies binding to the polypeptides, methods for identifying modulators, methods of treatment utilizing the polypeptides.

4. Claims: 1,5,12-35 (all partially)

HPR1 amino acid sequences comprising fragments of SEQ. ID. NO: 4 fused to fragments of SEQ. ID. NO: 10, isolated polynucleotides encoding the polypeptides, expression vectors and host cells containing these sequences, processes for producing the polypeptides, antibodies binding to the polypeptides, methods for identifying modulators, methods of treatment utilizing the polypeptides.

5. Claims: 1,5,12-35 (all partially)

HPR1 amino acid sequences comprising fragments of SEQ. ID. NO: 4 fused to fragments of SEQ. ID. NO: 11, isolated polynucleotides encoding the polypeptides, expression

## FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

vectors and host cells containing these sequences, processes for producing the polypeptides, antibodies binding to the polypeptides, methods for identifying modulators, methods of treatment utilizing the polypeptides.

6. Claims: 2 and 8 (completely), 5 and 12-35 (partially)

An isolated polypeptide HPR1 comprising the amino acid sequence of SEQ. ID. NO: 12, subsequences thereof, fusions of subsequences of SEQ. ID. NO: 12, isolated polynucleotides encoding the polypeptides or comprising the nucleotide sequence SEQ. ID. NO: 28, expression vectors and host cells containing these sequences, processes for producing the polypeptides, antibodies binding to the polypeptides, methods for identifying modulators, methods of treatment utilizing the polypeptides.

7. Claims: 3, 5,9, 12-35 (all partially)

An isolated polypeptide HPR2 comprising the amino acid sequence SEQ. ID. NO: 23, subsequences thereof, isolated polynucleotides encoding the polypeptides or comprising the nucleotide sequence SEQ. ID. NO: 22, expression vectors and host cells containing these sequences, processes for producing the polypeptides, antibodies binding to the polypeptides, methods for identifying modulators, methods of treatment utilizing the polypeptides.

8. Claims: 3, 5,9, 12-35 (all partially)

An isolated polypeptide HPR2 comprising the amino acid sequence SEQ. ID. NO: 25, subsequences thereof, isolated polynucleotides encoding the polypeptides or comprising the nucleotide sequence SEQ. ID. NO: 24, expression vectors and host cells containing these sequences, processes for producing the polypeptides, antibodies binding to the polypeptides, methods for identifying modulators, methods of treatment utilizing the polypeptides.

9. Claims: 3, 5,12-35 (all partially)

HPR2 amino acid sequences comprising fragments of SEQ. ID. NO: 23 fused to SEQ. ID. NO: 16 or to fragments of SEQ. ID. NO: 16 or to SEQ. ID. NO: 17 or to SEQ. ID. NO: 18, isolated polynucleotides encoding the polypeptides, expression vectors and host cells containing these sequences, processes for producing the polypeptides, antibodies binding to the polypeptides, methods for identifying modulators, methods of treatment utilizing the polypeptides.

## FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

## 10. Claims: 4, 11 (completely), 5 and 12-35 (partially)

An isolated polypeptide HPR2 comprising the amino acid sequence SEQ. ID. NO: 27, subsequences thereof, isolated polynucleotides encoding the polypeptides or comprising the nucleotide sequence SEQ. ID. NO: 29, expression vectors and host cells containing these sequences, processes for producing the polypeptides, antibodies binding to the polypeptides, methods for identifying modulators, methods of treatment utilizing the polypeptides.

## 11. Claims: 5, 9 and 12-35 (all partially)

Polynucleotide sequences comprising SEQ. ID. NO: 19 or SEQ. ID. NO: 20, isolated polynucleotides encoding the polypeptides, expression vectors and host cells containing these sequences, processes for producing the polypeptides, antibodies binding to the polypeptides, methods for identifying modulators, methods of treatment utilizing the polypeptides.



FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box 1.2

Claims Nos.: 5,12-15,18, 27-30, 32-35

Present claims 5,12-15,18, 27-30, 32-35 relate to an extremely large number of possible compounds/products. Support within the meaning of Article 6 PCT and/or disclosure within the meaning of Article 5 PCT is to be found, however, for only a very small proportion of the compounds/products. In the present case, the claims so lack support, and the application so lacks disclosure, that a meaningful search over the whole of the claimed scope is impossible. Consequently, the search has been carried out for those parts of the claims which appear to be supported and disclosed, namely those parts relating to the DNAs or proteins for which a sequence listing has been provided and to antibodies recognizing the claimed proteins.

The applicant's attention is drawn to the fact that claims, or parts of claims, relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure.

## INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 01/31634

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 9831811	A	23-07-1998	AU 5733898 A	07-08-1998
			EP 1005552 A1	07-06-2000
			JP 2001508309 T	26-06-2001
			WO 9831811 A1	23-07-1998
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			EP 1240325 A2	18-09-2002
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